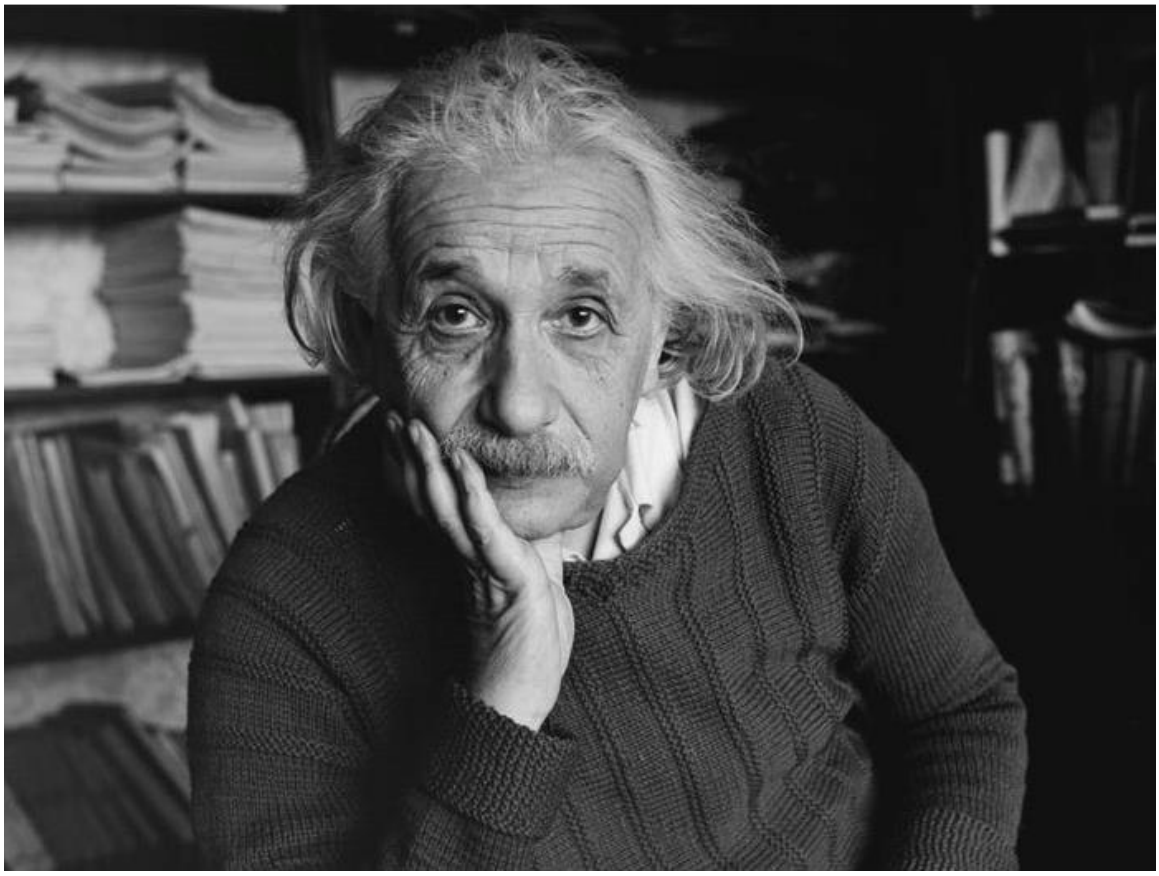
Genius Magazine



Volume Two

Genius Magazine: Volume Two

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Cover picture: Albert Einstein in his study at the Princeton Institute for Advanced Studies, 1948

If you have a submission for the **Genius Magazine** feel free to contact the magazine. The editor can be contacted at

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If we ponder over the question as to how the universe, considered as a whole, is to be regarded, the first answer that suggests itself is surely this …

Albert Einstein

Editor's Prologue

Obelisk Press of Vancouver is pleased to publish the second volume of ***Genius Magazine*** which serves to feature the work of aspiring artists. The ***Genius Magazine*** welcomes submissions on a bi-annual basis.

The featured Genius for this volume is Albert Einstein, one of the greatest scientists of all history and an iconic personality of the 20th century. He was a physicist, a philosopher and a humanist. Two of his books *The World as I See It* and *Ideas and Opinions* are required reading for all those who claim to be modern a humanist and avant-garde. Along with studying his physics, I read his philosophy as a young man and it has been a guiding influence in my life as a humanist. The lessor known side of his life is the role that Einstein played in writing President Franklin D. Roosevelt in 1939 encouraging the US to undertake nuclear research and the work that Einstein undertook with the US Navy as part of the Manhattan project (*Dr. Yukawa Comes to America*).

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The Writings of Albert Einstein

Einstein's Letter - The Beginnings of the Manhattan Project

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable—through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium

by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States.

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,

Albert Einstein

A Popular Account of Johannes Kepler by Albert Einstein

In anxious and uncertain times like ours, when it is difficult to find pleasure in humanity and the course of human affairs, it is particularly consoling to think of such a supreme and quiet man as Kepler. Kepler lived in an age in which the reign of law in nature was as yet by no means certain. How great must his faith in the existence of natural law have been to give him the strength to devote decades of hard and patient work to the empirical investigation of planetary motion and the mathematical laws of that motion, entirely on his own, supported by no one and understood by very few! If we would honour his memory fittingly, we must get as clear a picture as we can of his problem and the stages of his solution.

Copernicus had opened the eyes of the most intelligent to the fact that the best way to get a clear grasp of the apparent movements of the planets in the heavens was to regard them as movements round the sun conceived as stationary. If the planets moved uniformly in circle round the sun, it would have been comparatively easy to discover how these movements must look from the earth. Since, however, the phenomena to be dealt with were much more complicated than that, the task was far harder. First of all, these movements had to be determined empirically from the observations of Tycho Brahe. Only then did it become possible to think about discovering the general laws which these movements satisfy.

To grasp how difficult a business it was even to determine the actual movements round the sun one has to realize the following. One can never

really see where a planet really is at any given moment, but only in the direction it can be seen just then from the earth, which is itself moving in an unknown manner round the sun. The difficulties thus seemed practically insurmountable.

Kepler had to discover a way of bringing order into this chaos. To start with he saw that it was necessary to try to find out about the motion of the earth itself. This would simply have been impossible if there existed only the sun, the earth and the fixed stars, but no other planets. For in that case one could ascertain nothing empirically except how the direction of the straight sun-earth line changes in the course of the year (apparent movement of the sun with reference to the fixed stars). In this way it is possible to discover that these sun-earth directions all lay in a plane stationary with reference to the fixed stars, at least according to the accuracy of observation achieved in those days, when there were no telescopes. By this means it could also be ascertained in what manner the line sun-earth revolves round the sun. It turned out that the angular velocity of this motion would vary in a regular way in the course of the year. But this was not of much use, as it was still not known how the distance from the earth to the sun alters in the course of the year. Only when these changes were known, could the real shape of the earth's orbit and the manner in which it is described be ascertained.

Kepler found a marvellous way out of this dilemma. To begin with it followed from observations of the sun that the apparent path of the sun against the background of the fixed stars differed in speed at different times of the year, but that the angular velocity of this movement was always the same at

the same time of the astronomical year, and therefore that the speed of rotation of the straight line earth-sun was always the same when it pointed to the same region of the fixed stars. It was thus legitimate to suppose that the earth's orbit was closed, described by the earth in the same way each year – which was by no means obvious a priori. For the adherents of the Copernican system it was thus as good as certain that this must also apply to the orbits of the rest of the planets.

This certainly made things easier. But how to ascertain the real shape of the earth's orbit? Imagine a brightly shining lantern M somewhere in the plane of the orbit. Assume we know that this lantern remains permanently in its place and thus forms a kind of fixed triangulation point for determining the earth's orbit, a point which the inhabitants of the earth can take a sight on at any time of year. Let this lantern M be further away from the sun than the earth. With the help of such a lantern it was possible to determine the earth's orbit in the following way:

First of all, in every year there comes a moment when the earth E lies exactly on the line joining the sun S and the lantern M. If at this moment we look from the earth E at the lantern M, our line of sight will coincide with the line SM (sun-lantern). Suppose the latter to be marked in the heavens. Now imagine the earth in a different position and at a different time. Since the sun S and the lantern M can both be seen from the earth, the angle at E in the triangle SEM is known. But we also know the direction of SE in relation to the fixed stars through direct solar observations, while the direction of the line SM in relation to the fixed stars has previously been ascertained once for all.

In the triangle SEM we also know the angle at S. Therefore, with the base SM arbitrarily laid down on a sheet of paper, we can, in virtue of our knowledge of the angles at E and S. construct a triangle SEM. We might do this at frequent intervals during the year; each time we should get on our piece of paper a position of the earth E with a date attached to it and a certain position in relation to the permanently fixed base SM. The earth's orbit would therefore be empirically determined, apart from its absolute size, of course.

But, you will say, where did Kepler get his lantern M? His genius and nature, benevolent in this case, gave it to him. There was, for example, the planet Mars; and the length of the Martian year – i.e., one rotation of Mars round the sun – was known. At one point, it may happen that the sun, the earth, and Mars lie very nearly on a straight line. This position of Mars regularly recurs after one, two, etc., Martian years, as Mars moves in a closed orbit. At these known moments, therefore, SM always presents the same base, while the earth is always at a different point in its orbit. The observations of the sun and Mars at these moments thus constitutes a means of determining the true orbit of the earth, as Mars then plays the part of our imaginary lantern. Thus it was that Kepler discovered the true shape of the earth's orbit and the way in which the earth describes it, and we who come after may well admire and honour him for it.

Now that the earth's orbit had been empirically determined, the true position and length of the line SE at any moment was known, and it was not so terribly difficult for Kepler to calculate the orbits and motions of the rest of the planets, too, from observations – at least in principle. It was

nevertheless an immense task, especially considering the state of mathematics at the time.

Now came the second and no less arduous part of Kepler's life-work. The orbits were empirically known, but the laws had to be guessed from the empirical data. First he had to make a guess at the mathematical nature of the curve described by the orbit, and then try it out on a vast assemblages of figures. If it did not fit, another hypothesis had to be devised and again tested. After a tremendous search, the conjecture that the orbit was an ellipse with the sun at one foci was found to fit the facts. Kepler also discovered the law governing the variation in speed during one revolution, which is that the line between sun-planet sweeps out equal areas in equal periods of time. Finally he also discovered that the squares of the periods of revolution round the sun vary as the cubes of the major axes of the ellipse.

Our admiration for this splendid man is accompanied by another feeling of admiration and reverence, the object of which is the mysterious harmony of nature into which we are born. The ancients already devised the lines exhibiting the simplest conceivable form of regularity. Among these, next to the straight line and the circle, the most important were the ellipse and hyperbola. We see the last two embodied – at least very nearly so – in the orbits of the heavenly bodies.

It seems that the human mind has first to construct forms independently before we can find them in things. Kepler's marvellous achievement is a particularly fine example of the truth that knowledge cannot spring from

experience alone but only from the comparison of the inventions of the intellect with observed facts.

{first published in a Nuremberg Newspaper in 1930}

James Clerk Maxwell by Albert Einstein

The belief in an external world independent of the perceiving individual is the basis of all natural science. Since, however, sense perception only gives information of this external world or of "physical reality" indirectly, we can only grasp the latter by speculative means. It follows from this that our notions of physical reality can never be final. We must always be ready to change theses notions – that is to say, the axiomatic basis of physics – in order to do justice to perceived facts in the most perfect way logically. Actually a glance at the development of physics shows that it has undergone far-reaching changes in the course of time.

The greatest change in the axiomatic basis of physics – in other words, of our conception of the structure of reality – since Newton laid the foundation of theoretical physics was brought about by Faraday's and Maxwell's work on electromagnetic phenomena. We will try in what follows to make this clearer, keeping both earlier and later developments in sight.

According to Newton's system, physical reality is characterized by the concepts of space, time, material point, and force (reciprocal action of material points). Physical events, in Newton's view, are to be regarded as the motions, governed by fixed laws, of material points in space. The material point is our only mode of representing reality when dealing with changes taking place in it, the solitary representative of the real, in so far as the real is capable of change. Perceptible bodies are obviously responsible for the concept of the material point; people conceived it as an analogue of mobile bodies, stripping

these of the characteristics of extension, form, orientation in space, and all "inward" qualities, leaving only inertia and translation and adding the concept of force. The material bodies, which had led psychologically to our formation of the concept of the "material point," had now themselves to be regarded as systems of material points. It should be noted that this theoretical scheme is in essence an atomistic and mechanistic one. All happenings were to be interpreted purely mechanically – that is to say, simply as motions of material points according to Newton's law of motion

The most unsatisfactory side of this system (apart from the difficulties involved in the concept of "absolute space" which have been raised once more quite recently) lay in its description of light, which Newton also conceived, in accordance with this system, as composed of material points. Even at that time the question, – What in that case becomes of the material points of which light is composed, when the light is absorbed? – was really a burning one. Moreover, it is unsatisfactory in any case to introduce into the discussion material points of quite a different sort, which had to be postulated for the purpose of representing ponderable matter and light respectively. Later on, electrical corpuscles were added to these, making a third kind, again with completely different characteristics. It was, further, a fundamental weakness that the forces of reciprocal action, by which events are determined, had to be assumed hypothetically in a perfectly arbitrary way. Yet this conception of the real accomplished much: how came it that people felt themselves impelled to forsake it?

In order to put his system into mathematical form at all, Newton had to devise the concept of differential calculus and propound the laws of motion in the form of differential equations – perhaps the greatest advance in thought that a single individual was ever privileged to make. Partial differential equations were not necessary for this purpose, nor did Newton make systematic use of them; but they were necessary for the formulation of the mechanics of deformable bodies; that is connected with the fact that in these problems the questions of how bodies are supposed to be constructed out of material points was of no importance to begin with.

Thus the partial differential equation entered theoretical physics as a handmaid, but has gradually become mistress. This began in the nineteenth century when the wave-theory of light established itself under the pressure of observed fact. Light in empty space was explained as a matter of vibrations of the ether, and it seemed idle at that stage, of course, to look upon the latter as a conglomeration of material points. Here for the first time the partial differential equation appeared as a natural expression of the primary realities of physics. In a particular department of theoretical physics the continuous field thus appeared side by side with the material point as the representative of physical reality. This dualism remains even today, disturbing as it must be to every orderly mind.

If the idea of physical reality had ceased to be purely atomic, it still remained for the time being purely mechanistic; people still tried to explain all events as the motion of inert masses; indeed no other way of looking at things seemed conceivable. Then came the great change, which will be associated for all

times with the names of Faraday, Maxwell and Hertz. The lion's share in this revolution fell to Maxwell. He showed that the whole of what was then known about light and electromagnetic phenomena was expressed in his well-known double system of differential equations in which the electric and the magnetic fields appear as the dependent variables. Maxwell did, indeed try to explain, or justify, these equations by the intellectual construction of a mechanical model.

But he made use of several such constructions at the same time and took none of them really seriously, so that the equations alone appeared as the essential thing and the field strengths as the ultimate entities, not to be reduced to anything else. By the turn of the century the conception of the electromagnetic field as an ultimate entity had been generally accepted and serious thinker had abandoned the belief in the justification, or the possibility, of a mechanical explanation of Maxwell's equations. Before long they were, on the contrary, actually trying to explain material points and their inertia on field theory lines with the help of Maxwell's theory, an attempt which did not, however, meet with complete success.

Neglecting the important individual results which Maxwell's life-work produced in important departments of physics, and concentrating on the changes wrought by him in our conception of the nature and physical reality, we may say this: before Maxwell's people conceived of physical reality – in so far as it is supposed to represent events in nature – as material points, whose changes consists exclusively of motions, which are subject to total differential equations. After Maxwell they conceived physical reality as represented by

continuous fields, not mechanistically explicable, which are subject to partial differential equations. This change in the conception of reality is the most profound and fruitful one that has come to physics since Newton; but it has at the same time to be admitted that the program has by no means been completely carried out yet. The successful systems of physics which have been evolved since rather represent compromises between these two schemes, which for that very reason bear a provisional, logically incomplete character, although they may have achieved great advances in certain particulars.

The first of these that calls for mention is Lorentz's theory of electrons, in which the field and the electrical corpuscles appear side by side as elements of equal value for the comprehension of reality. Next come the Special and General Theory of Relativity, which, though based entirely on ideas connected with the field-theory, have so far been unable to avoid the independent introduction of material points and total differential equations.

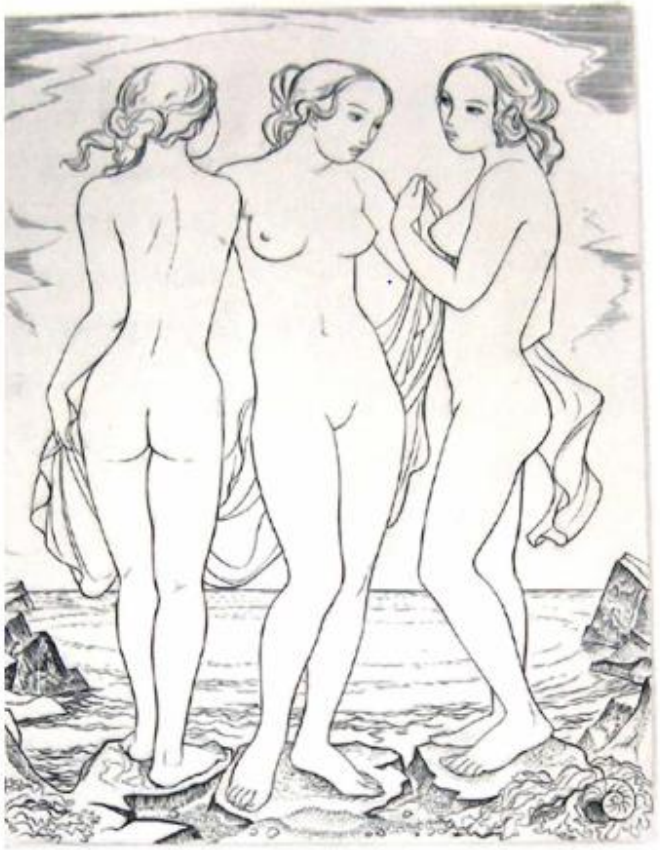
The last and most successful creation of theoretical physics, namely quantum-mechanics, differs fundamentally from both the schemes which we will for the sake of brevity call the Newtonian and the Maxwellian. For the quantities which figure in its laws make no claim to describe physical reality itself, but only the probabilities of the occurrence of a physical reality that we have in view. Dirac, to whom, in my opinion, we owe the most perfect exposition, logically, of this theory, rightly points out that it would probably be difficult, for example, to give a theoretical description of a photon such as would give enough information to enable one to decide whether it will pass a polarizer placed (obliquely) in its way or not.

I am still inclined to the view that physicists will not in the long run content themselves with that sort of indirect description of the real, even if the theory can eventually be adapted to the postulates of General Relativity in a satisfactory manner.

We shall then, I feel sure, have to return to the attempt to carry out the program which may be described properly as the Maxwellian – namely, the description of physical reality in terms of fields which satisfy partial differential equations without singularities.

{Full title: *Maxwell's Influence on the Evolution of the Idea of Physical Reality*, first published in 1931}

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Editor in Chief: Patrick Bruskiewich

The Ether and the Theory of Relativity by Albert Einstein

How does it come about that alongside of the idea of ponderable matter, which is derived by abstraction from everyday life, the physicists set the idea of the existence of another kind of matter, the ether? The explanation is probably found in these phenomena which have given rise to the theory of action at a distance, and in the properties of light which have led to the wave theory. Let us consider these two subjects:

Outside of physics we know nothing of action at a distance. When we try to connect cause and effect in experiences which natural objects afford us, it seems at first as if there were no other mutual actions than those of immediate contact (e.g. the communication of motion by impact, push and pull, heating or induction combustion by means of a flame, etc.) It is true that even in everyday experience weight, which is in a sense action at a distance, plays an important part.

But since in daily experience the weight of bodies is something constant, something not linked to any cause which is variable in time or place, we do not in everyday life speculate as to the cause of gravity, and therefore do not become conscious of its character as action at a distance.

It was Newton's theory of gravitation that first assigned a cause for gravity by interpreting it as action at a distance, proceeding from masses. Newton's theory is probably the greatest stride ever made in the efforts towards understanding the causality of natural phenomena.

And yet this theory evoked a lively sense of discomfort amongst Newton's contemporaries, because it seemed to be in conflict with the principle springing from the rest of experience, that there can be reciprocal action only through contact, and not through immediate action at a distance.

It is only with reluctance that man's desire for knowledge endures a dualism of this kind. How was unity to be preserved in his comprehension of the forces of nature? Either by trying to look upon contact forces as being themselves distant forces which admittedly are observable only at a very short distance – and this was the road which Newton's followers, who were entirely under the spell of his doctrine, mostly preferred to take; or by assuming that the Newtonian action at a distance is apparently immediate action at a distance, but in truth is conveyed by a medium permeating space, whether by movements or by elastic deformation of this medium.

Thus the endeavour toward a unified view of the nature of forces leads to the hypothesis of an ether. This hypothesis, to be sure, did not at first bring with it any advance in the theory of gravitation or in physics generally, so that it becomes customary to treat Newton's law of force as an axiom not further reducible. But the ether hypothesis was bound always to play some part in physical science, even if at first only a latent part.

When in the first half of the nineteenth century the far-reaching similarity was revealed which subsists between the properties of light and those of elastic waves in ponderable bodies, the ether hypothesis found fresh support. It

appeared beyond question that light must be interpreted as a vibratory process in an elastic, inert medium filling up universal space. It also seemed to be a necessary consequence of the fact that light is capable of polarization that this medium, the ether, must be of the nature of a solid body, because transverse waves are not possible in a fluid, but only in a solid. Thus the physicists were bound to arrive at the theory of the "quasi-rigid" luminiferous ether, the parts of which can carry out no movements relatively to one another except the small movements of deformation which correspond to light-waves.

This theory – also called the theory of the stationary luminiferous ether – more-over [editor's note: – *did not* find –] a strong support in an experiment which is also of fundamental importance in the *Special Theory of Relativity* – the experiment of Fizeau – from which one was obliged to infer that the luminiferous ether does not take part in the movements of bodies. The phenomenon of Aberration [editor's note: – *also does not favour* –] the theory of the quasi-rigid ether.

The development of the theory of electricity along the path opened by Maxwell and Lorentz gave the development of our ideas concerning the ether quite a peculiar and unexpected turn. For Maxwell himself the ether indeed still had properties which were purely mechanical, although of a much more complicated kind than the mechanical properties of tangible solid bodies. But neither Maxwell nor his followers succeeded in elaborating a mechanical model for the ether which might furnish a satisfactory mechanical interpretation of Maxwell's laws of the electro-magnetic field. The laws were clear and simple, the mechanical interpretations clumsy and contradictory.

Almost imperceptibly the theoretical physicists adapted themselves to a situation which, from the standpoint of their mechanical programme, was very depressing. They were particularly influenced by the electro-dynamical investigations of Heinrich Hertz. For whereas they previously had required of a conclusive theory that it should content itself with the fundamental concepts which belong exclusively to mechanics (e.g. densities, velocities, deformations, stresses) they gradually accustomed themselves to admitting electric and magnetic force as fundamental concepts side by side with those of mechanics, without requiring a mechanical interpretation for them. Thus the purely mechanical view of nature was gradually abandoned. But this change had to be fundamental dualism which in the long-run was insupportable. A way of escape was now sought in the reverse direction, by reducing the principles of mechanics to those of electricity, and this especially as confidence in the strict validity of the equations of Newton's mechanics was shaken by the experiments with β– rays and rapid cathode rays.

This dualism still confronts us in unextenuated form in the theory of Hertz, where matter appears not only as the bearer of velocities, kinetic energy, and mechanical pressures, but also as the bearer of electromagnetic fields. Since such fields also occur *in vacuo* – i.e. in free ether – the ether also appears as bearer of electromagnetic fields. The ether appears indistinguishable in its functions from ordinary matter. Within matter it takes part in the motion and in empty space it has everywhere a velocity; so that the ether has a definitely assigned velocity throughout the whole of space. There is no fundamental difference between Hertz's ether and ponderable matter (which in part subsists in the ether).

The Hertz theory suffered not only from the defect of ascribing to matter and ether, on the one hand mechanical states, and on the other hand electrical states, which do not stand in any conceivable relation to each other; it was also at variance with the result of Fizeau's important experiment on the velocity of the propagation of light in moving fluids, and with other established experimental results.

Such was the state of things when H.A. Lorentz entered upon the scene. He brought theory into harmony with experience by means of a wonderful simplification of theoretical principles. He achieved this, the most important advance in the theory of electricity since Maxwell by taking from ether its mechanical, and from matter its electromagnetic qualities. As in empty space, so too in the interior of material bodies, the ether, and not matter viewed atomistically, was extensively the seat of electromagnetic fields. According to Lorentz the elementary particles of matter were alone capable of carrying out movements; their electromagnetic activity is entirely confined to the carrying of electric charges. Thus Lorentz succeeded in reducing all electromagnetic happenings to Maxwell's equations in free space.

As to the mechanical nature of the Lorentzian ether, it may be said of it, in a somewhat playful spirit, that immobility is the only mechanical property of which it has not been deprived by H.A. Lorentz. It may be added that the whole change in the conception of the ether which the *Special Theory of Relativity* brought about, consisted in taking away from the ether its last

mechanical quality, namely, its immobility. How this is to be understood will forthwith be expounded.

The space-time theory and the kinematics of the *Special Theory of Relativity* were modelled on the Maxwell-Lorentz Theory of the electromagnetic field. This theory therefore satisfies the conditions of the *Special Theory of Relativity*, but when viewed from the latter it acquires a novel aspect. For if K be a system of coordinates relatively to which the Lorentzian ether is at rest, the Maxwell-Lorentz equations are valid primarily with reference to K. But by the *Special Theory of Relativity* the same equations without any change of meaning also held in relation to any new system of co-ordinates K' which is moving in uniform translation relative to K. Now comes the anxious question – Why must I in the theory distinguish the K system above all K' systems, which are physically equivalent to it in all respects, by assuming that the ether is at rest relatively to the K system? For the theoretician such an asymmetry in the theoretical structure, with no corresponding asymmetry in the system of experience, is intolerable. If we assume the ether to be at rest relative to K, but in motion relative to K', the physical equivalence of K and K' seems to me from the logical standpoint, not indeed downright incorrect, but nevertheless inacceptable.

The next position which it was possible to take up in face of this state of things appeared in the following. The ether does not exist at all. The electromagnetic fields are not states of a medium and are not bound down to any bearer, but they are independent realities which are not reducible to anything else, exactly like the atoms of ponderable matter. This conception suggests itself the more

readily as, according to Lorentz's theory, electromagnetic radiation, like ponderable matter, brings impulse and energy with it, and as, according to the *Special Theory of Relativity*, both matter and radiation are but special forms of distributed energy, ponderable mass losing its isolation and appearing as a special form of energy.

More careful reflection teaches us, however, that the *Special Theory of Relativity* does not compel us to deny the ether. *We may assume the existence of an ether; only we must give up ascribing a definite state of motion to it, i.e. we must by abstraction take from it the last mechanical characteristic which Lorentz had still left it.* We shall later see that this point of view, the conceivability of which I shall at once endeavour to make more intelligible by a somewhat halting comparison, is justified by the results of the *General Theory of Relativity*.

Think of waves on the surface of water. Here we can describe two entirely different things. Either we may observe how the undulatory surface forming the boundary between water and air alters in the course of time; or else – with the help of small floats, for instance – we can observe how the position of the separate particles of water alters in the course of time. If the existence of such floats for tracking the motion of the particles of the fluid were a fundamental impossibility in physics – if, in fact, nothing else whatever were observable than the shape of space occupied by the water as it varies in time, we should have no ground for the assumption that water consist of movable particles. But all the same we could characterize it as a medium.

We have something like this in the electromagnetic field. For we may picture the field to ourselves as consisting of lines of force. If we wish to interpret these lines of force to ourselves as something material in the ordinary sense, we are tempted to interpret the dynamical processes as motions of these lines of force, such that each separate line of force is tracked through the course of time. It is well known, however, that this way of regarding the electromagnetic field leads to contradictions.

Generalising we must say this: - There may be supposed to be extended physical objects to which the idea of motion cannot be applied. They may be thought of as consisting of particles which allow themselves to be separately tracked through time. In Minkowski's idiom this is expressed as follows: - Not every extended conformation in the four-dimensional world can be composed of world-lines. *The Special Theory of Relativity forbids us to assume the ether to consist of particles observable through time, but the hypothesis of ether in itself is not in conflict with the Special Theory of Relativity. Only we must be on guard against ascribing a state of motion to the ether.*

Certainly, from the standpoint of the *Special Theory of Relativity,* the ether hypothesis appears at first to be an empty hypothesis. In the equations of the electromagnetic field there occur, in addition to the densities of the electric charge, *only* the intensities of the fields. The career of electromagnetic processes *in vacuo* appears to be completely determined by these equations, uninfluenced by other physical quantities. The electromagnetic fields appear as ultimate, irreducible realities, and at first it seems superfluous to postulate

a homogeneous, isotropic ether-medium, and to envisage electromagnetic fields as states of this medium**.**

But on the other hand there is weighty argument to be adduced in favour of the ether hypothesis. To deny the ether is ultimately to assume that empty space has no physical qualities whatever. The fundamental facts of mechanics do not harmonize with this view. For the mechanical behaviour of a corporeal system hovering freely in empty space depends not only on relative positions (distances) and relative velocities, but also on its state of rotation, which physically may be taken as a characteristic not appertaining to the system in itself.

In order to be able to look upon the rotation of the system, at least formally, as something real, Newton objectifies space. Since he classes his absolute space together with real things, for him rotation relative to an absolute space is also something real. Newton might no less well have called his absolute space "Ether"; what is essential is merely that besides observable objects, another thing, which is not perceptible, must be looked upon as real, to enable acceleration or rotation to be looked upon as something real.

It is true that Mach tried to avoid having to accept as real something which is not observable, by endeavouring to substitute in mechanics a mean acceleration with reference to the totality of the masses in the universe, in place of an acceleration with reference to absolute space. But inertial resistance opposed to relative acceleration of distant masses presupposes action at a distance; and as the modern astrophysicist does not believe that he

may accept this action at a distance, he comes back once more, if he follows Mach, to the ether, which has to serve as medium for the effects of inertia. But this conception of the ether to which we are led by Mach's way of thinking differs essentially from the ether as conceived by Newton, by Fresnel, and by Lorentz. Mach's ether not only *conditions* the behaviour of inert masses, but is *also conditioned* in its state by them.

Mach's idea finds its full development in the ether of the *General Theory of Relativity*. According to this theory, the metrical qualities of the continuum of Space-Time differ in the environment of different points of Space-Time, and are partly conditioned by the matter existing outside of the territory under consideration. This Space-Time variability of the reciprocal relations of the standards of Space and Time, or, perhaps, the recognition of the fact that "empty space" in its physical relation is neither homogeneous nor isotropic, compelling us to describe its state by ten functions (the gravitational potentials $g_{\mu\nu}$), has, I think, finally disposed of the view that space is physically empty.

But therewith the conception of the ether has again acquired an intelligible content, although this content differs widely from that of the ether of the mechanical undulatory theory of light. The ether of the General Theory of Relativity is a medium which is itself devoid of all mechanical and kinematical qualities, but helps to determine mechanical (and electromagnetic) events.

What is fundamentally new in the ether of the *General Theory of Relativity* as opposed to the ether of Lorentz consists in this, that the state of the former

is at every place determined by connections with the matter and the state of ether in neighbouring places, which are amenable to law in the form of differential equations; whereas the state of the Lorentzian ether in the absence of electromagnetic fields is conditioned by nothing outside itself, and is everywhere the same. The ether of the *General Theory of Relativity* is transmitted conceptually into the ether of Lorentz if we substitute constants for the functions of space which describe the former, disregarding the causes which condition its state. Thus we may also say, I think, that the ether of the *General Theory of Relativity* is the outcome of the Lorentzian ether, through the application of the theory.

As to the part which the new ether is to play in the physics of the future we are not yet clear. We know that it determines the metrical relations in the Space-Time continuum, e.g. the configurative possibilities of solid bodies as well as the gravitational fields; but we do not know whether it has an essential share in the structure of the electrical elementary particles constituting matter. Nor do we know whether it is only in the proximity of ponderable masses that its structure differs essentially from the Lorentzian ether; whether the geometry of spaces of cosmic extent is approximately Euclidean. But we can assert by reason of the relativistic equations of gravitation that there must be a departure from Euclidean relations, with spaces of cosmic order of magnitude, if there exists a positive mean density, no matter how small, of the matter in the universe.

In this case the universe must of necessity be spatially unbounded and of finite magnitude, its magnitude being determined by the value of the mean density.

If we consider the gravitational field and the electromagnetic field from the standpoint of the ether hypothesis, we find a remarkable distance between the two. There can be no space, nor any part of space, without gravitational potentials; for these confer upon space its metrical qualities, without which it cannot be imagined at all. The existence of the gravitational field is inseparably bound up with the existence of space. On the other hand a part of space may well be imagined without an electromagnetic field; thus in contrast with the gravitational field, the electromagnetic field seems to be only secondarily linked to the ether, the formal nature of the electromagnetic field being as yet in no way determined by that of gravitational ether. From the present state of theory it looks as if the electromagnetic field, as opposed to the gravitational field, rests upon an entirely new formal motif, as though nature just as well have endowed the gravitational ether with fields of quite another type, for example, with fields of a [editor's note: *metrical*] potential, instead of fields of the electromagnetic type.

Since according to our present conceptions the elementary particles of matter are also, in their essence, nothing else than condensations of the electromagnetic field, our present view of the universe presents two realities which are completely separated from each other conceptually, although connected casually, namely, gravitational ether and electromagnetic field, or – as they might also be called – space and matter.

Of course it would be a great advance if we could succeed in comprehending the gravitational field and the electromagnetic field together as one unified conformation. Then for the first time the epoch of theoretical physics founded

by Faraday and Maxwell would reach a satisfactory conclusion. The contrast between ether and matters would fade away, and, through the *General Theory of Relativity,* the whole of physics would become a complete system of thought, like geometry, kinematics, and the theory of gravitation.

An exceedingly ingenious attempt in this direction has been made by the mathematician H. Weyl; but I do not believe that his theory will hold its ground in relation to reality. Further, in contemplating the immediate future of theoretical physics we ought not unconditionally to reject the possibility that the facts comprised in the quantum theory may set bounds to the field theory beyond which it cannot pass.

Recapitulating, we may say that according to the General Theory of Relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether. According to the General Theory of Relativity space without ether is unthinkable; for in such a space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any Space-Time intervals in the physical sense.

But this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it.

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Geometry and Experience by Albert Einstein

One reason why mathematics enjoys special esteem, above all other sciences, is that its laws are absolutely certain and indisputable, while those of all other sciences are to some extent debatable and in constant danger of being overthrown by newly discovered facts. In spite of this, the investigator in another department of science would not need to envy the mathematician if the laws of mathematics referred to objects of our mere imagination and not to objects of reality. For it cannot occasion surprise that different person should arrive at the same logical conclusions when they have already agreed upon the fundamental laws (axioms), as well as the methods by which other laws are to be deduced therefrom. But there is another reason for the high repute of mathematics, in that it is mathematics which affords the exact natural science a certain measure of security, to which without mathematics they could not attain.

At this point an enigma presents itself in all ages has agitated inquiring minds. How can it be that mathematics, being after all a product of human thought which is independent of experience, is so admirably appropriate to the objects of reality? Is human reason, then, without experience, merely taking thought, able to fathom the properties of real things.

In my opinion the answer to this question is, briefly, this: - As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality. It seems to me complete clearness as to this state of things first because common property through that new departure

in mathematics which is known by the name of mathematical logic or "Axiomatics." The progress achieved by axiomatics consists in its having neatly separated the logical-formal from its objective or intuitive content; according to axiomatics the logical-formal alone forms the subject-matter of mathematics, which is not concerned with the intuitive of other content associated with the logical-formal.

Let us for a moment consider from this point of view any axiom of geometry, for instance, the following: – Through two points of space there always passes one and only on straight line. How is this axiom to be interpreted in the older sense and in the more modern sense?

The older interpretation: – Every one knows what a straight line is, and what a point is. Whether this knowledge springs from the human mind or form experience, from some collaboration of the two or from other source, is not for the mathematician to decide. He leaves the question to the philosopher. Being based upon this knowledge, which precedes all mathematics, the axiom stated above is, like all other axioms, self-evident, that is, it is the expression of a part of this *a prior* knowledge.

The more modern interpretation: – Geometry treats of entities which are denoted by the words straight line, point, etc. These entities do not take for granted any knowledge or intuition whatever, but they presuppose only the validity of the axioms, such as the one stated above, which are to be taken in a purely formal sense, i.e. as void of all content of intuition or experience. These axioms are free creations of the human mind. All other propositions of

geometry are logical inferences from the axioms (which are to be taken in the normalistic sense only). The matter geometry deals with is first defined through axioms. Schick in his book on epistemology has therefore characterised axioms very aptly as "implicit definitions."

This view of axioms, advocated by modern axiomatics, purges mathematics of all extraneous elements, and thus dispels the mystic obscurity which formerly surrounded the principles of mathematics. But a presentation of its principles thus clarified makes it also evident that mathematics as such cannot predicate anything about perceptual objects of real objects. In axiomatic geometry the words "point," "straight line," etc. stand only for empty conceptual schemata. That which gives them substance is not relevant to mathematics.

Yet on the other hand it is certain that mathematics generally, and particularly geometry, owes its existence to the need which was felt of learning something about the relations of things to one another. The very word geometry, which, of course, means earth-measuring, proves this. For earth-measuring has to do with the possibilities of the disposition of certain natural objects with respect to one another, namely, with parts of the earth, measuring-lines, measuring-wands, etc. It is clear that the system of concepts of axiomatic geometry alone cannot make any assertions as to the relations of real objects of this kind, which we will call practically-rigid bodies. To be able to make such assertions, geometry must be stripped of its merely logical-formal character by the co-ordination of real objects of experience with the empty conceptual frame-work of axiomatic geometry. To accomplish this, we need only add

the proposition: – Solid bodies are related, with respect to their possible dispositions, as are bodies in Euclidean geometry of three dimensions. Then the propositions of Euclid contain affirmation as to the relations or practically-rigid bodies.

Geometry thus completed is evidently a natural science: we may in fact regard it as the most ancient branch of physics. Its affirmations rest essentially on induction from experience, but not on logical inferences only. We will call this completed geometry "practical geometry," and shall distinguish it in what follows from "purely axiomatic geometry." The question whether the practical geometry of the universe is Euclidean or not has a clear meaning, and its answer can only be furnished by experience. All linear measurement in physics is practical geometry in his sense, so too is geodetic and astronomical linear measurement, if we call to our help the law of experience that light is propagated in a straight line, and indeed in a straight line in the sense of practical geometry.

I attach special importance to the view of geometry which I have just set forth, because without it I should have been unable to formulate the *Theory of Relativity*. Without it the following reflection would have been impossible: – In a system of reference rotating relatively to an inert system, the laws of disposition of rigid bodies do not correspond to the rules of Euclidean geometry on account of the Lorentz contraction; thus if we admit non-inertial systems we must abandon Euclidean geometry. The decisive step in the transition to general co-variant equations [editor's note: to the *General Theory of Relativity*] would certainly not have been taken if the above interpretation

had not served as a stepping-stone. If we deny the relation between the body of axiomatic Euclidean geometry and the practically-rigid body of reality, we readily arrive at the following view, which was entertained by that acute and profound thinker, H. Poincaré: – Euclidean geometry is distinguished above all other imaginable axiomatic geometries by its simplicity. Now since axiomatic geometry by itself contains no assertions as to the reality which can be experienced, but can do so only in combination with physical laws, it should be possible and reasonable – whatever may be the nature of reality – to retain Euclidean geometry.

For if contradictions between theory and experience manifest themselves, we should rather decide to change physical laws than to change axiomatic Euclidean geometry. If we deny the relationship between the practically-rigid body and geometry, we shall indeed not easily free ourselves from the convention that Euclidean geometry is to be retained as the simplest.

Why is the equivalence of the practically-rigid body and the body of geometry – which suggests itself so readily – denied by Poincaré and other investigators? Simply because under closer inspection the real solid bodies in nature are not rigid, because their geometrical behaviour, that is, their possibilities of relative disposition, depend upon temperature, external forces, etc.

Thus the original, immediate relation between geometry and physical reality appears destroyed, and we feel impelled towards the following general view, which characterizes Poincaré's standpoint. Geometry (G) predicates nothing

about the relations of real things, but only geometry together with the purport (P) of physical laws can do so. Using symbols we may sat that only the sum of (G) + (P) is subject to the control of experience. Thus (G) may be chosen arbitrarily, and also parts of (P); all these laws are conventions. All that is necessary to avoid contradictions is to choose the remainder of P so that (G) and the whole of (P) are together in accord with experience. Envisaged in this way, axiomatic geometry and the part of natural law which have been given a conventional status appear as epistemologically equivalent.

Sub specie aeterni Poincaré, in my opinion, is right. The idea of the measuring-rod and the idea of the clock co-ordinated with it in the *Theory of Relativity* do not find their exact correspondence in the real world. It is also clear that the solid body and the clock do not in the conceptual edifice of physics play the part of irreducible elements, but that of composite structures, which may not play any independent part in theoretical physics. But it is my conviction that in the present stage of development of theoretical physics these ideas must still be employed as independent ideas; for we are still far from possessing such certain knowledge of theoretical principles as to be able to give exact theoretical constructions of solid bodies and clocks.

Further, as to the objection that there are no really rigid bodies in nature, and that therefore the properties predicated of rigid bodies do not apply to physical reality, – this objection is by no means so radical as might appear from a hasty examination. For it is not a difficult task to determine the physical state of a measuring-rod so accurately that its behaviour relatively to other measuring-bodies shall be sufficiently free from ambiguity to allow it to be substituted

for the "rigid" body. It is to measuring-bodies of this kind that statements as to rigid bodies must be referred.

All practical geometry is based upon a principle which is accessible to experience, and which we will now try to realise. We will call that which is enclosed between two boundaries, marked upon a practically-rigid body, a tract.

We imagine two practically-rigid bodies, each with a tract marked out on it. These two tracts are said to be "equal to one another" if the boundaries of the one tract can be brought to coincide permanently with the boundaries of the other. We now assume that:

> If two tracts are found to be equal once and anywhere, they are equal always and everywhere.

Not only the practical geometry of Euclid, but also its nearest generalization, the practical geometry of Riemann, and therewith the *General Theory of Relativity*, rest upon this assumption. Of the experimental reasons which warrant this assumption I will mention only one.

The phenomenon of the propagation of light in empty space assigns a tract, namely, the appropriate path of light, to each interval of local time, and conversely. Thence is follows that the above assumption for tracts must also hold good for intervals of clock-time in the *General Theory of Relativity*.

Consequently it may be formulated as follows: – If two ideal clocks are going at the same rate at any time and at any place (being then in immediate proximity to each other), they will always go at the same rate, no matter where and when they are again compared with each other at one place. – If this law were not valid for real clocks, the proper frequencies for the separate atoms of the same chemical element would not be in such exact agreement as experience demonstrates. The existence of sharp spectral lines is a convincing experimental proof of the above-mentioned principle of practical geometry. This is the ultimate foundation in fact which enables as to speak with the meaning of mensuration, in Riemann's sense of the word, of the four-dimensional continuum of Space-Time.

The question whether the structure of this continuum is Euclidean, or in accordance with Riemann's general scheme, or otherwise, is, according to the view which is here being advocated, properly speaking a physical question which must be answered by experience, and not a question of a mere convention to be selected on practical grounds. Riemann's geometry will be the right things if the laws of disposition of practically-rigid bodies are transformable into those of the bodies of Euclid's geometry with an exactitude which increases in proportion as the dimensions of the part of Space-Time under consideration are diminished.

It is true that this proposed physical interpretation of geometry breaks down when applied immediately to spaces of sub-molecular order of magnitude. But nevertheless, even in questions as to the constitution of elementary particles, it retains part of its importance. For ever when it is a question of

describing the electrical elementary particles constituting matter, the attempt may still be made to ascribe physical importance to those ideas of fields which have been physically defined for the purpose of describing the geometrical behaviour of bodies which are large as compared with the molecule. Success alone can decide as to the justification of such an attempt, which postulates physical reality for the fundamental principles of Riemann's geometry outside of the domain of their physical definitions. It might possibly turn out that this extrapolation has no better warrant than the extrapolation of the idea of temperature to parts of a body of molecular order of magnitude.

It appears less problematical to extend the ideas of practical geometry to spaces of cosmic order of magnitude. It might, of course, be objected that a construction composed of solid rods departs more and more from ideal rigidity in proportion as its spatial extent becomes greater.

But it will hardly be possible, I think, to assign fundamental significance to this objection. Therefore the question whether the universe is spatially finite or not seems to me decidedly a pregnant question in the sense of practical geometry. I do not even consider it impossible that this question will be answered before long by astronomy. Let us call to mind what the *General Theory of Relativity* teaches us in this respect. It offers two possibilities

1. The universe is spatially infinite. This can be so only if the average spatial density of the matter in the universal space, concentrated in the stars, vanishes, i.e. if the ratio of the total mass of the stars to the magnitude of the space

through which they are scattered approximates indefinitely to the value zero when the spaces taken into consideration are constantly greater and greater.

2. The universe is spatially finite. This must be so, if there is a mean density of the ponderable matter in universal space differing from zero. The smaller that mean density, the greater is the volume of universal space.

I must not fail to mention that a theoretical argument can be adduced in favour of the hypothesis of a finite universe. The *General Theory of Relativity* teaches us that the inertia of a given body is greater as there are more ponderable masses in proximity to it, thus it seems very natural to reduce the total effect on inertia of a body to action and reaction between it and other bodies in the universe, as indeed, ever since Newton's time, gravity has been completely reduced to action and reaction between bodies. From the equations of the *General Theory of Relativity* it can be deduced that this total reduction of inertia to reciprocal action between masses – as required by E. Mach , for example – is possible only if the universe is spatially finite.

On many physicists and astronomers this argument makes no impression. Experience alone can finally decide which of the two possibilities is realised in nature. How can experience furnish an answer? At first it might seem possible to determine the mean density of matter by observation of that of the universe which is accessible to our perception. This hope is illusory. The distribution of the visible stars is extremely irregular, so that we on no account may venture to set down the mean density of star-matter in the universe as equal, let us say, to the mean density of the Milky Way. In any case, however

great the space examined may be, we could not feel convinced that there were no more stars beyond that space. So it deems impossible to estimate the mean density.

But there is another road, which seems to me more practicable, although it also presents great difficulties. For if we inquire into the deviations shown by the consequences of the *General Theory of Relativity* which are accessible to experience, when these are compared with the consequences of the Newtonian theory, we first of all find a deviation which shows itself in close proximity to gravitating mass, and has been confirmed in the case of the planet Mercury. But if the universe is spatially finite there is a second deviation from the Newtonian theory, which, in the language of the Newtonian theory, may be expressed thus: – the gravitational field is in its nature such as if it were produced, not only by the ponderable masses, but also by a mass-density of negative sign, distributed uniformly throughout space. Since this factitious mass-density would have to be enormously small, it could make its presence felt only in gravitating systems of very great extent.

Assuming that we know, let us say, the statistical distribution of the stars in the Milky Way, as well as their masses, then by Newton's law we can calculate the gravitational field and the mean velocities which the stars must have, so that the Milky Way should not collapse under the mutual attraction of its stars, but should maintain its actual extent. Now if the actual velocities of the stars, which can, of course, be measured, were smaller than the calculated velocity, we should have a proof that the actual attractions at great distances are smaller than by Newton's law. From such a deviation it could

be proved indirectly that the universe is finite. It would even be possible to estimate its spatial magnitude.

Can we picture to ourselves a three-dimensional universe which is finite, yet unbounded?

The usual answer to this question is "No," but that is not the right answer. The purpose of the following remarks is to show that the answer should be "Yes." I want to show that without any extraordinary difficulty we can illustrate the theory of a finite universe by means of a mental image to which, with some practice, we shall soon grow accustomed.

First of all, an observation of epistemological nature. A geometrical-physical theory as such is incapable of being directly pictures, being merely a system of concepts. But these concepts serve the purpose of bringing a multiplicity of real or imaginary sensory experiences in the mind. To "visualise" a theory, or bring it home to one's mind, therefore means to give a representation to that abundance of experiences for which the theory supplies the schematic arrangement. In the present case we had to ask ourselves how we can represent that relation of solid bodies with respect to their reciprocal disposition (contact) which corresponds to the theory of a finite universe. There is nothing new in what I have to say about this; but innumerable questions addressed to me prove that the requirements of those who thirst for knowledge of these matters have not yet been completely satisfied. So, will the initiated please pardon me, if part of what I shall bring forward has long been known?

What do we wish to express when we say that our space is infinite? Nothing more than that we might lay any number whatever of bodies of equal sizes side by side without ever filling space. Suppose that we are provided with a great many wooden cubes all the same size. In accordance with Euclidean geometry we can place them above, beside, and behind one another so as to fill a part of space of any dimensions; but this construction would never be finished; we could go on adding more and more cubes without ever finding that there was no more room. That is what we wish to express when we say that space in infinite. It would be better to say that space is infinite in relation to practically-rigid bodies, assuming that the laws of disposition for these bodies are given by Euclidean geometry.

Another example of an infinite continuum is the plane. On a plane surface we may lay squares of cardboard so that each side of any square has the side of another square adjacent to it. The construction is never finished; we can always go on laying squares – if their laws of disposition correspond to those pane figures of Euclidean geometry. The plane is therefore infinite in relation to the cardboard squares. Accordingly we say that the plane is an infinite continuum of two dimensions, and space an infinite continuum of three dimensions. What is here meant by the number of dimensions. I think I may assume to be known.

Now we take an example of a two-dimensional continuum which is finite, but unbounded. We imagine the surface of a large globe and a quantity of small paper discs, all the same size. We place one of the discs anywhere on the

surface of the globe. If we move the disc about, anywhere we like, on the surface of the globe, we do not come upon a limit or boundary anywhere on the journey. Therefore we say that the spherical surface of the globe is an unbounded continuum. Moreover, the spherical surface is a finite continuum. For if we stick the paper discs on the globe, so that no disc overlaps another, the surface of the globe will finally become so full that there is no room for another disc. This simply means that the spherical surface of the globe is finite in relation to the paper discs. Further, the spherical surface is a non-Euclidean continuum of two dimensions, that is to say, the laws of disposition for the rigid figures lying in it do not agree with those of the Euclidean plane. This can be shown in the following way. Place a paper disc on the spherical surface, and around it in a circle place six more discs, each of which is to be surrounded in turn by six discs, and so on. If this construction is made on a plane surface, we have an uninterrupted disposition in which there are six discs touching every disc except those which lie on the outside.

On the spherical surface the construction also seems to promise success at the outset, and the smaller the radius of disc in proportion to that of the sphere, the more promising it seems. But as the construction progresses it becomes more and more patent that the disposition of the disc in the manner indicated, without interruption, is not possible, as it should be possible by Euclidean geometry of the plane surface. In this way creatures which cannot leave the spherical surface and cannot peer out from the spherical surface into three-dimensional space, might discover, merely by experimenting with discs, that their two-dimensional "space" is not Euclidean, but spherical space.

From the latest results of the *General Theory of Relativity* it is possible that our three-dimensional space is also approximately spherical, that is, that the laws of disposition of rigid bodies in it are not given by Euclidean geometry, but approximately by spherical geometry, but approximately by spherical geometry, if only we consider parts of space which are sufficiently great. Now this is the place where the reader's imagination boggles. "Nobody can imagine this thing," he cries indignantly. "It can be said, but cannot be thought. I can represent to myself a spherical surface well enough, but nothing analogous to it in three-dimensions."

We must try to surmount this barrier in the mind, and the patient reader will see that it is by no means a particularly difficult task. For this purpose we will first give our attention once more to the geometry of two-dimensional spherical surfaces. Let K be a spherical surface sitting on a plane at point S. Let L be a disc on the spherical surface. Now let us imagine that the point N on the spherical surface, diametrically opposite to S, there is a light throwing a shadow L' of the disc L upon the plane. Every point on the sphere has a shadow on the plane. If the disc on the surface of the sphere is moved, its shadow L' on the plane also moves. When the disc L is at S, it almost exactly coincides with its shadow. If it moves on the spherical surface away from S upwards, the shadow L' one the plane also moves away from S on the plane outwards, growing bigger and bigger. As the disc L approaches the point N, the shadow moves off to infinity.

Now we put the question – What are the laws of disposition of the disc-shadows L' onto the plane? Evidently they are exactly the same as the laws

of disposition of the discs L on the spherical surface. For to each original figure on K there is a corresponding shadow figure on E. If two discs on K are touching, there shadows on the plane also touch. The shadow-geometry on the plane agrees with the disc-geometry on the sphere. If we call the disc-shadows rigid figures, then spherical geometry holds good on the plane surface with respect to these rigid figures. Moreover, the plane is finite with respect to the disc-shadows, since only a finite number of the shadows can find room on the plane.

At this point somebody will say. "That is nonsense. The disc-shadows are not rigid figures. We have only to move a two-foot rule about on the plane to convince ourselves that the shadows constantly increase in size as they move away from S on the plane towards infinity." But what if the two-foot rule were to behave on the plane in the same way as the disc-shadow l'? It would then be impossible to show that the shadows increase in size as they move away from S; such an assertion would then no longer have any meaning whatever. In fact the only objective assertion that can be made is just this, that they are related in exactly the same way as are the rigid discs on the spherical surface in the sense of Euclidean geometry.

We must carefully bear in mind that our statement as to the growth of the disc-shadows, as they move away from S towards infinity, has in itself no objective meaning, as long as we are able to employ Euclidean rigid bodies which can be moved about on the plane for the purpose of comparing the size of the disc-shadows. In respect of the laws of disposition of the shadows L', the point S has no special privileges on the plane any more than on the spherical surface.

The representation given above of spherical geometry on the plane is important for us, because it readily allows itself to be transferred to the three-dimensional case.

Let us imagine a point S of our space, and a great number of small spheres, L', which can all be brought to coincide with one another. But these sphere are not to be rigid in the sense of Euclidean geometry; their radius is to increase (in the sense of Euclidean geometry) when they are moved away from S towards infinity, and this increase is to take place in exact accordance with the same law as applies to the increase of the radii of the disc-shadow L' on the plane.

After having gained a vivid mental image of the geometrical behaviour of our L' spheres, let us assume that in our space there are no rigid bodies at all in the sense of Euclidean geometry, but only bodies having the behaviour of our L' spheres.

Then we shall have a vivid representation of three-dimensional spherical space, or, rather of three-dimensional spherical geometry. Here our spheres must be called "rigid" spheres. Their increase in size as they depart from S is not to be detected by measuring with measuring-rods, any more than in the case of the disc-shadows on the plane, because the standards of measurement behave in the same way as the spheres. Space is homogenous, that it to say, the spherical configurations are possible in the environments of all points.

Our space is finite, because, in consequence of the "growth" of the spheres, only a finite number of them can find room in space.

In this way, by using as stepping-stones the practice in thinking and visualization which Euclidean geometry gives us, we have acquired a mental picture of spherical geometry. We may without difficulty impart more depth and vigour to these ideas by carrying out special imaginary constructions. Nor would it be difficult to represent the case of what is called elliptical geometry in an analogous manner.

My aim today has been to show that the human faculty of visualization is by no means bound to capitulate to non-Euclidean geometry.

{first published in 1921}

What is the Theory of Relativity? by Albert Einstein

I gladly accede to the request of your colleague to write something for *The Times* on Relativity. After the lamentable breakdown of the old active intercourse between men of learning, I welcome the opportunity of expressing my feelings of joy and gratitude towards the astronomers and physicists of England. It is thoroughly in keeping with the great and proud traditions of scientific work that eminent scientists should have to spent much time and trouble, and your scientific institutions have spared no expense, to test the implications of a theory which was perfected and published during the war in the land of your enemies. Even though the investigation of the influence of the gravitational field of the sun on light rays is a purely objective matter, I cannot forbear to express my personal thanks to my English colleagues for their work; for without it I could hardly have lived to see the most important implications of my theory tested.

We can distinguish various kinds of theories in physics. Most of them are constructive. They attempt to build up a picture of the more complex phenomena out of the materials of a relatively simple formal scheme from which they start out. Thus the kinetic theory of gases seeks to reduce mechanical, thermal, and diffusional processes to the movements of molecules – i.e. to build them up out of the hypothesis of molecular motion. When we say that we have succeeded in understanding a group of natural processes, we invariably mean that a constructive theory has been found which covers the process in question.

Along with this most important class of theories there exists a second, which I shall call ``principle-theories.`` These employ the analytic, not the synthetic, method. The elements which form their basis and starting-point are not hypothetically constructed but empirically discovered ones, general characteristics of natural processes, principles that give rise to mathematically formulated criteria which the separate processes or the theoretical representations of them have to satisfy. Thus the science of thermodynamics seeks by analytical means to deduce the necessary conditions, which separate events have to satisfy, from the universally experienced fact that perpetual motion is impossible.

The advantages of the constructive theory are completeness, adaptability, and clarity, those of the principle-theory are logical perfection and security of the foundations.

The Theory of Relativity belongs to the latter class. In order to grasp its nature, one needs first of all to become acquainted with the principles on which it is based. Before I go into these, however, I must observe that the Theory of Relativity resembles a building consisting of two separate stories, the Special Theory and the General Theory.

The Special Theory, on which the General Theory rests, applies to all physical phenomena with the exception of gravitation; the General Theory provides the law of gravitation and its relations to other forces of nature.

It has, of course, been known since the days of the ancient Greeks that in order to describe the movement of a body, a second body is needed to which the movement of the first is referred. The movement of a vehicle is considered in reference to the earth`s surface, that of a planet to the totality of the visible fixed stars. In physics the body to which events are spatially referred is called the coordinate system. The laws of mechanics of Galileo and Newton, for instance, can only be formulated with the aid of a coordinate system.

The state of motion of the coordinate system may not, however, be arbitrarily chosen, if the laws of mechanics are to be valid (it must be free from rotation and acceleration). A coordinate system which is admitted in mechanics is an "inertial system." The state of motion of an inertial system is according to mechanics not one that is determined uniquely by nature. On the contrary, the following definition holds good: a coordinate system that is moved uniformly and in steady straight line relative to an inertial system is likewise an inertial system.

By the *Special Theory of Relativity* is mean the generalization of this definition to include any natural event whatever: thus, [*the first principle on which the Special Theory of Relativity rests is*] every universal law of nature which is valid in relation to a coordinate system C, must also be valid, as it stands, in relations to a coordinate system C`, which is in uniform translator motion relatively to C.

The second principle, on which the *Special Theory of Relativity* rests is the "principle of the constant velocity of light in vacuo." This principle asserts

that light in vacuo always has a definite velocity of propagation (independent of the state of motion of the observer or of the source of light). The confidence which physicists place in this principle springs from the successes achieved by the electrodynamics of Maxwell and Lorentz.

Both of the above-mentioned principles are powerfully supported by experience, but appear not to be logically reconcilable. The *Special Theory of Relativity* finally succeeded in reconciling them logically by a modification of kinematics – i.e. of the doctrine of the laws relating to space and time (from the point of view of physics). It became clear that to speak of the simultaneity of two events had no meaning except in relation to a given coordinate system, and that the shape of measuring devices and the speed at which clocks move depend on their state of motion with respect to the coordinate system.

But the old physics, including the laws of motion of Galileo and Newton, did not fit in with the suggested relativistic kinematics. From the latter, general mathematical conditions issued, to which natural laws had to conform, if the above-mentioned two principles were really to apply. To these, physics had to be adapted. In particular, scientists arrived at a new law of motion for (rapidly moving) mass points, which was admirably confirmed in the case of electrically charged particles. The most important consequence of the *Special Theory of Relativity* concerned the inertia of a system necessarily depends on its energy-content, and this led straight to the notion that inert mass is simply latent energy. The principle of the Conservation of Mass lost its independence and became fused with that of the Conservation of Energy.

The *Special Theory of Relativity*, which was simply a systematic development of the electrodynamics of Maxwell and Lorentz, pointed beyond itself, however. Should the independence of physical laws of the state of motion of the coordinate system be restricted to the uniform translator motion of coordinate systems in respect to each other? What has nature to do with our coordinate systems and their state of motion? If it is necessary for the purpose of describing nature, to make use of coordinate system arbitrarily introduced by us, then the choice of its state of motion ought to be subject to no restriction: the laws ought to be entirely independent of their choice (*General Theory of Relativity*).

The establishment of this *General Theory of Relativity* is made easier by a fact of experience that has long been known, namely, that the weight and the inertia of a body are controlled by the same constant (equality of inertial and gravitational mass). Imagine a coordinate system which is rotating uniformly with respect to an inertial system in the Newtonian manner. The centripetal [*editor's note centrifugal forces do not exist*] which manifest themselves in relation to this system must according to Newton's teaching, be regarded as effects of inertia. But these centripetal forces are, exactly like the forces of gravity, proportional to the masses of the bodies. Ought it not be possible in this case to regard the coordinate system as stationary and the centripetal forces as gravitational?

This hasty consideration suggests that a *General Theory of Relativity* must supply the laws of gravitation, and the consistent following up of the idea has justified our hopes.

But the path was thornier than might one suppose, because it demanded the abandonment of Euclidean geometry. This is to say, the laws according to which solid bodies may be arranged in space do not completely accord with the spatial laws attributed to bodies by Euclidean geometry. This is what we mean when we talk of the "curvature of space." The fundamental concepts of the "straight line," the "plane", etc. thereby lose their precise significance in physics.

In the *General Theory of Relativity* the doctrine of Space-Time, or kinematics, no longer figures as a fundamental independent of the rest of physics. The geometrical behaviour of bodies and the motion of clocks rather depend on gravitational fields, which in their turn are produced by matter.

The new theory of gravitation diverges considerably, as regards principles, from Newton's theory. But its practical results agree so nearly with those of Newton's theory that it is difficult to find criteria for distinguishing them which are accessible to experience.

Such have been discovered so far:

1. In the precession of the perihelion of the planetary orbits around the sun (confirmed in the case of Mercury).

2. In the curving of light rays by the action of gravitational fields (confirmed by the English photographs of the 1919 eclipse).

3. In a displacement of the spectral lines toward the red end of the spectrum in the case of light transmitted to us from stars of considerable magnitude.

The chief attraction of the theory lies in its logical completeness. If a single one of the conclusions drawn from it proves wrong, it must be given up; to modify it, without destroying the whole structure seems to be impossible.

Let no one suppose, however, that the mighty work of Newton can really be superseded by this or any other theory. His great and lucid ideas will retain their unique significance for all time as the foundation of our whole modern conceptual structure in the sphere of natural philosophy.

{first published in 1919}

Outside and Inside the Elevator by A. Einstein and L. Infeld

The law of inertia marks the first great advance in physics, in fact, its real beginning. It was gained by the contemplation of an idealized experiment, a body moving forever with no friction nor any other external forces acting. From this example and later from many others, we recognized the importance of the idealized experiment created by thought. Here again, idealized experiments will be discussed. Although these may sound very fantastic they will, nevertheless, help us to understand as much about relativity as is possible by our simple methods.

We had previously the idealized experiments with a uniformly moving room. Here, for a change, we shall have a falling elevator.

Imagine a great elevator at the top of a skyscraper much higher than any real one. Suddenly the cable supporting the elevator breaks and the elevator falls freely toward the ground. Observers in the elevator are performing experiments during the fall. In describing them, we need not bother about air resistance or friction, for we may disregard their existence under our idealized conditions. One of the observers takes a handkerchief and a watch from his pocket and drops them. What happens to these two bodies? For the outside observer, who is looking through the window of the elevator, both the handkerchief and watch fall toward the ground in exactly the same way, with the same acceleration. We remember that the acceleration of a falling body is quite independent of its mass and that it was this fact which revealed the equality of gravitational and inertial mass. We also remember that the

equality of the two masses, gravitational and inertial, was quite accidental from the point of view of classical mechanics and played a role in its structure. Here, however, this equality is reflected in the equal acceleration of all falling bodies is essential and forms the basis of our whole argument.

Let us return to our falling handkerchief and watch, for the outside observer they are falling with the same acceleration. But so is the elevator, with its walls, ceiling and floor. Therefore the distance between the two bodies and the floor will not change. For the inside observer the two bodies remain exactly where they were when he let them go. The inside observer may ignore the gravitational field. Since its source lies outside of his CS (*Coordinate System*). He finds that no forces inside the elevator act upon the two bodies, and so they are at rest, just as if they were in an inertial CS. Strange things happen in the elevator! If the observer pushes a body in any direction, up or down for instance, it always moves uniformly as long as it does not collide with the ceiling or the floor of the elevator. Briefly speaking, the laws of classical mechanics are valid for the observer in the elevator. All bodies behave in the way expected by the law of inertia. Our new CS rigidly connected with the freely falling elevator differs from the inertial CS in only one respect. In an inertial CS, a moving body on which no forces are acting will move uniformly forever. The CS as represented in classical physics is neither limited in space nor time.

The case of the observer in our elevator, however, different. The inertial character of his CS is limited in space and time. Sooner or later the uniformly moving body will collide with the wall of the elevator, destroying the uniform

motion. Sooner or later the whole elevator will collide with the earth destroying the observer and their experiments. The CS is only a "pocket edition" of a real inertial CS.

The local character of the CS is quite essential. If our imaginary elevator were to reach from the North Pole to the equator, with the handkerchief placed over the North Pole and watch at the equator, then, for the outside observer, the two bodies would not have the same acceleration, they would not be as rest relative to each other. Our whole argument would fail! The dimensions of the elevator must be limited so that the equality of acceleration of all bodies relative to the outside observer may be assumed.

With this restriction, the CS takes on an inertial character for the inside observer. We can at least indicate a CS in which all the physical laws are valid, even though it is limited in time and space. If we imagine another CS, another elevator moving uniformly, relative to the one falling freely, then both these CS will be locally inertial. All laws are exactly the same in both. The transition from one to the other is given by the Lorentz transformation.

Let us see in what way both the observers, outside and inside, describe what takes place in the elevator.

The outside observer notices the motion of the elevator and all bodies in the elevator, and finds them in agreement with Newton's gravitational law. For him, the motion is not uniform, but accelerated, because of the action of the gravitational field of the earth.

However, a generation of physicists born and brought up in the elevator would reason quite differently. They would believe themselves in possession of an inertial system and would refer to all laws of nature to their elevator, stating with justification that the laws take on a specially simple form in their CS. It would be natural for them to assume their elevator at rest and their CS the inertial one.

It is impossible to settle the differences between the outside and the inside observers. Each of them could claim the right to refer to all events to his CS. Both descriptions of events could be made equally consistent.

We see from this example that a consistent description of physical phenomena in two different CS is possible, even if they are not moving uniformly, relative to each other. But for such a description we must take into account gravitation, building so to speak, the "bridge" which effects a transition from one CS to the other. The gravitational field exists for the outside observer; it does not for the inside observer. Accelerated motion for the elevator in the gravitational field exists for the outside observer; rest and absence of the gravitational field for the inside observer. But the "bridge," for the gravitational field, making the description in both CS possible, rests on one very important pillar; the equivalence of gravitational and inertial mass. Without this clue, unnoticed in classical mechanics, our present argument would fail completely.

Now for a somewhat different idealized experiment. There is, let us assume, an inertial CS, in which the law of inertia is valid. We have already described what happens in an elevator resting in an inertial CS. But we now change our picture. Someone outside has fastened a rope to the elevator and is pulling, with a constant force, in the [editor's note: upwards] direction ... It is immaterial how this is done. Since the laws of mechanics are valid in this CS, the whole elevator moves with a constant acceleration in the direction of motion. Again we shall listen to the explanation of phenomena going on in the elevator and given by both the outside and inside observers.

The Outside Observer: My CS is an inertial one. The elevator moves with constant acceleration, because a constant force is acting. The observers inside are in absolute motion, for them the laws of mechanics are invalid. They do not find that bodies, on which no forces are acting, are at rest. If a body is left free, it soon collides with the floor of the elevator, since the floor moves upward toward the body. This happens exactly in the same way for the watch and for the handkerchief. It seems very strange to me that the observer inside the elevator must always be on the "floor" because as soon as he jumps, the floor will reach him again.

The Inside Observer: I do not see any reason for believing that any observer is in absolute motion. I agree that my CS, rigidly connected with my elevator, is not really inertial, but I do not believe that it has anything to do with absolute motion. My watch, my handkerchief, and all bodies are falling because the whole elevator is in a gravitational field. I notice exactly the same kind of

motion as the man on the earth. He explains them very simply by the action of a gravitational field. The same holds good for me.

These two descriptions, one by the outside, and the other by the inside, observer, are quite consistent, and there is no possibility of deciding which of them is right. We may assume either one of them for the description of phenomena in the elevator; either non-uniform motion and the absence of a gravitational field with the outside observer, or rest and the presence of a gravitational field with the inside observer.

The outside observer may assume that the elevator is in "absolute" non-motion. But a motion which is wiped out by the assumption of an acting gravitational field cannot be regarded as absolute motion.

This is, possibly, a way out of the ambiguity of two different descriptions, and a decision in favour of one against the other could perhaps be made. Imagine that a light ray enters the elevator horizontally through a side window and reaches the opposite wall after a very short time. Again let us see how the path of the light would be predicted by the two observers.

The outside observer, believing in accelerated motion of the elevator, would argue: The light ray enters the window and moves horizontally, along a straight line and with a constant velocity, toward the opposite wall. But the elevator moves upward and during the time in which the light travels toward the wall, the elevator changes in position. Therefore, the ray will meet a point not exactly opposite its point of entrance, but a little below. The difference

will be very slight, but it exists nevertheless, and the light ray travels, relative to the elevator, not along a straight line, but a slightly curved line. The difference is due to the distance covered by the elevator during the time the ray is crossing the interior.

The inside observer, who believes in the gravitational field acting on all objects in his elevator, would say: there is no accelerated motion of the elevator, but only the action of the gravitational field. A beam of light is weightless and, therefore, will not be affected by the gravitational field. If sent in a horizontal direction, it will meet the wall at a point exactly opposite to that at which it entered.

It seems from this discussion that there is the possibility of deciding between these two opposite points of view as the phenomenon would be different for the two observers. If there is nothing illogical in either of the explanations just quoted, then the whole previous argument is destroyed, and we cannot describe all phenomena in two consistent ways, with and without a gravitational field.

But there is, fortunately, a grave fault in the reasoning of the inside observer, which saves our previous conclusion. He said: "A beam of light is weightless and, therefore, it will not be affected by the gravitational field." This cannot be right! A beam of light carries energy, and energy has mass. But every inertial mass is attracted by the gravitational field exactly as a body would if thrown horizontally with a velocity equal to that of light. If the inside observer had reasoned correctly and had taken into account the bending of light rays in

a gravitational field, then his results would have been exactly the same as those of an outside observer.

The gravitational field of the earth is, of course, too weak for the bending of light rays in it to be proved directly, by experiments. But the famous experiments performed during the solar eclipses show, conclusively though indirectly, the influence of a gravitational field on the path of a light ray.

It follows from these examples that there is a well-founded hope of formulating a relativistic physics. But for this we must first tackle the problem of gravitation.

We saw from the example of the elevator the consistency of the two descriptions. Non-uniform motion may, or may not, be assumed. We can eliminate "absolute" motion from our examples by a gravitational field. But then there is nothing absolute in the non-uniform motion. The gravitational field is able to wipe it out completely.

The ghosts of absolute motion and inertial CS can be expelled from physics and a new relativistic physics built. Our idealized experiments show how the problem of the *General Theory of Relativity* is closely connected with that of gravitation and why the equivalence of gravitational and inertial mass is so essential for this connection. It is clear that the solution of the gravitational problem in the *General Theory of Relativity* must differ from the Newtonian one. The laws of gravitation must, just as all laws of nature, be formulated

for all possible CS, whereas the laws of classical mechanics, as formulated by Newton, are valid only in inertial CS.

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Considerations on the Universe as a Whole by Albert Einstein

Cosmological Difficulties of Newton's Theory

If we ponder over the question as to how the universe, considered as a whole, is to be regarded, the first answer that suggests itself is surely this: As regards space (and time) the universe is infinite. There are stars everywhere, so that the density of matter, although very variable in detail, is nevertheless on the average everywhere the same. In other words: However far we might travel through space, we should find everywhere an attenuated swarm of fixed stars of approximately the same kind and density.

This view is not in harmony with the theory of Newton. The later theory rather requires that the universe should have a kind of centre in which the density of the stars is a maximum, and that as we proceed outwards from this centre the group-density of the stars should diminish, until finally, at great distances, it is succeeded by an infinite region of emptiness. The stellar universe ought to a finite island in the infinite ocean of space.

This conception is in itself not very satisfactory. It is still less satisfactory because it leads to the result that the light emitted by the stars and also individual stars of the stellar system are perpetually passing out into infinite space, never to return, and without ever again coming into interaction with other objects of nature. Such a finite material universe would be destined to become gradually but systematically impoverished.

In order to escape this dilemma, Seelinger suggested a modification of Newton's law, in which he assumes that for great distances the force of attraction between two masses diminishes more rapidly than would result from the inverse square law. In this way it is possible for the mean density of matter to be constant everywhere, even to infinity, without infinitely large gravitational fields being produced. We thus free ourselves from the distasteful conception that the material universe ought to possess something of the nature of a centre.

Of course we purchase our emancipation from the fundamental difficulties mentioned, at the cost of a modification and complication of Newton's law which has neither empirical nor theoretical foundation. We can imagine innumerable laws which would serve the same purpose, without our being able to state a reason why one of them is to be preferred to the others; for any one of these laws would be founded just as little on more general theoretical principles as the law of Newton.

The Possibility of a "Finite" and Yet "Unbounded" Universe

But speculations on the structure of the universe also move in quite another direction. The development of non-Euclidean geometry led to the recognition of the fact, that we can cast doubt on the infiniteness of our space without coming into conflict with the laws of thought or with experience (Riemann, Helmholtz). These questions have already been treated in detail and with unsurpassed lucidity by Helmholtz and Poincaré, whereas I can only touch on them briefly here.

In the first place, we imagine an existence in two-dimensional space. Flat beings with flat implements, and in particular flat rigid measuring-rods, are free to move in a plane. For then nothing exists outside of this plane: that which they observe to happen to themselves and to flat "things" is the all-inclusive reality of their plane …

In contrast to ours, the universe of these beings is two-dimensional; but, like ours, it extends to infinity. In their universe there is room for an infinite number of identical squares made up of rods, i.e. its volume (surface) is infinite. If these beings say their universe is "plane," there is sense in the statement, because they mean that they can perform the constructions of plane Euclidean geometry with their rods. In this connection the individual rods always represent the same direction, independently of their position.

Let us consider now a second two-dimensional existence, but this time on a spherical surface instead of on a plane. The flat beings with their measuring-rods and other objects fit exactly on this surface and they are unable to leave it. Their whole universe of observation extends exclusively over the surface of the sphere. Are these beings able to regard the geometry of their universe as being plane geometry and their rods withal as the realisation of "distance"?

They cannot do this. For if they attempt to realise a straight line, they will obtain a curve, which we "three-dimensional beings" designate as a great circle, i.e., a self-contained line of definite finite length, which can be measured up by means of a measuring-rod. Similarly, this universe has a finite

area, that can be compared with the area of a square constructed with rods. The great charm resulting from this consideration lies in the recognition of the fact that *the universe of these beings is finite and yet has no limit*.

But the spherical-surface beings do not need to go on a world-tour in order to perceive they are not living in a Euclidean universe. They can convince themselves of this on every part of their world "world," provided they do not use too small a piece of it. Starting from a point, they draw "straight lines" (arcs of circles as judged in three-dimensional space) of equal length in all directions. They will call the line joining the free ends of these lines a "circle."

For a plane surface, the ratio of the circumference of a circle to its diameter, both lengths being measured with the same rod, is, according to Euclidean geometry of the plane, equal to a constant value π, which is independent of the diameter of the circle.

Of their spherical surface our flat beings would find for this ratio the value

$$\pi \sin (r/R) / (r/R)$$

i.e. a smaller value than π, the difference being the considerable, the greater is the radius of the circle in comparison with the radius R of the "world-sphere." By means of this relation the flat beings can determine the radius of their universe ("world"), even when only a relatively small part of their world-sphere is available for their measurements. But if this part is very small indeed, they will no longer no able to demonstrate that they are on a spherical

"world" and not on a Euclidean plane, for a small part of a spherical surface differs only slightly from a piece of a plane of the same size.

Thus if the spherical-surface beings are living on a planet of which the solar system occupies only a negligibly small part of the spherical universe, they have no means of determining whether they are living in a finite or in an infinite universe, because the "piece of universe" to which they have access is in both case practically plane, or Euclidean.

It follows directly from this discussion, that for our sphere-beings the circumference of a circle first increases with the radius until the "circumference of the universe" is reached, and that it thenceforth gradually decreases to zero for still further increasing values of the radius. During this process the area of the circle continues to increase more and more, until finally it becomes equal to the total area of the whole "world-sphere."

Perhaps the reader will wonder why we have placed our "beings" on a sphere rather than on another closed surface. But this choice has its justifications in the fact that, of all closed surfaces, the sphere is unique in possessing the property that all points on it are equivalent. I admit that the ratio of the circumference c of a circle to its radius r depends on r, but for a given value of r it is the same for all points of the "world-sphere"; in other words, the "world-sphere" is a "sphere of constant curvature."

To this two-dimensional sphere-universe there is a three-dimensional analogy, namely, the three-dimensional spherical space which was discovered by

Riemann. Its points are likewise all equivalent. It possesses a finite volume, which is determined by its "radius" ($2\pi^2R^3$). Is it possible to imagine a spherical sphere? To imagine a space means nothing else than that we imagine an epitome of our "space" experience, i.e. of experience that we can have in the movement of "rigid" bodies. In this sense we *can* imagine a spherical space.

Suppose we draw lines or stretch strings in all directions from a point, and mark off from each of these the distance r with a measuring-rod. All the free end-points of these lengths lie on a spherical surface. We can specially measure up the area (F) of this surface by means of a square made up of measuring-rods. If the universe is Euclidean, then $F = 4\pi r^2$; if it is spherical, then F is always less than $4\pi r^2$. With increasing values of r, F increases from zero up to a maximum value which is determined by the "world-radius," but for still further increasing values of r, the area gradually diminishes to zero.

At first, the straight lines which radiate from the starting point diverge farther and farther from one another, but later they approach each other, and finally they run together at a "counter-point" to the starting point. Under such conditions they have traversed the whole spherical space. It is easily seen that the three-dimensional spherical space is quite analogous to the two-dimensional spherical surface. It is finite (i.e. of finite volume), and has no bounds.

It may be mentioned that there is yet another kind of curved space: "elliptical-space." It can be regarded as a curved space in which two "counter-points"

are identical (indistinguishable from each other). An elliptical universe can thus be considered to some extent as a curved universe possessing central symmetry.

It follows from what has been said, that closed spaces without limits are conceivable. From amongst these, the spherical space (and the elliptical) excels in simplicity, since all points on it are equivalent. As a result of this discussion, a most interesting question arises for astronomers and physicists, and that is whether the universe in which we live is infinite, or whether it is finite in the manner of the spherical universe.

Our experience is far from being sufficient to enable us to answer this question. But the *General Theory of Relativity* permits answering this question with a moderate degree of certainty, and in this connection the difficult mentioned above finds its solution.

The Structure of Space According to the General Theory of Relativity

According to the *General Theory of Relativity*, the geometrical properties of space are not independent but they are determined by matter. Thus we can draw conclusions about the geometrical structure of the universe only if we base our consideration on the state of matter as being something that is known. We know from experience that, for a suitably chosen co-ordinate system, the velocities of the stars are small compared with the velocity of the transmission of light. We can thus as a rough approximation arrive at a conclusion as to the nature of the universe as a whole, if we treat the matter as being at rest.

We already know from our previous discussion that the behaviour of measuring-rods and clock are influence by gravitation fields, i.e. by the distribution of matter. This in itself is sufficient to exclude the possibility of the exact validity of Euclidean geometry in our universe.

But it is conceivable that our universe differs only slightly from a Euclidean one, and this motion seems all the more probable, since calculations show that metrics of the surrounding space is influenced only to an exceedingly small extent by masses even the magnitude of our sun.

We might imagine that, as regards geometry, our universe behaves analogously to a surface which is irregularly curved in its individual parts, but which nowhere departs appreciably from a planet: something like the rippled surface of a lake. Such a universe might fittingly be called a quasi-Euclidean universe. As regards its space it would be infinite.

But calculation shows that in a quasi-Euclidean universe the average density of matter would necessarily be nil. Thus such a universe could not be inhabited by matter everywhere; it would present to us that unsatisfactory picture which we portrayed.

If we are to have in the universe an average density of matter which differ from zero, however small may be that difference, then the universe cannot be quasi-Euclidean. On the contrary, the results of calculations indicate that if matter be distributed uniformly, the universe would necessarily be spherical

(or elliptical). Since in reality the detailed distribution of matter is not uniform, the real universe will deviate in individual parts from the spherical, i.e. the universe will be quasi-spherical. But it will be necessarily finite. In fact, the theory supplies us with a simple connection between space-expanse of the universe and average density of matter in it, namely

$R^2 = 2 / G \kappa$

where G is the gravitational constant 6.67×10^{-11} Nm^2/kg^2 and κ is the average density of matter …

{first published in 1916}

Hubble and the Expansion of the Universe by Albert Einstein

… our knowledge about the structure of space in the large ("cosmological problem") has had an important development … My original considerations on the subject were based on two hypotheses:

1. There exists an average density of matter in the whole of space which is everywhere the same and different from zero.
2. The magnitude ("radius") of space is independent of time.

Both these hypotheses proved to be consistent, according to the General Theory of Relativity, but only after a hypothetical seem was added to the field equations, a term which was not required by the theory as much nor did it seem natural from a theoretical point of view ("cosmological term of the field equations").

Hypothesis (2) appeared unavoidable to me at the time, since I thought that one would get into bottomless speculations if one departed from it.

However, already in the 'twenties, the Russian mathematician Friedman showed that a different hypothesis was natural from a purely theoretical point of view. He realized that it was possible to preserve hypothesis (1) without introducing the less natural cosmological term into the field equations of gravitation, if one was ready to drop hypothesis (2). Namely, the original field equations admit a solution in which the 'world-radius" depends on time

(expanding space). In that sense one can say, according to Friedman, that the theory demands an expansion of space.

A few years later Hubble showed, by a special investigation of the extra-galactic nebulae, that the spectral lines emitted showed a red shift which increased regularly with the distance of the nebulae. This can be interpreted in regard to our present knowledge only in the sense of Doppler's principle, as an expansive motion of the system of stars in the large – as required, according to Friedman, by the field equations of gravitation. Hubble's discovery can, therefore, be considered to some extent as a confirmation of the theory.

There does arise, however, a strange difficulty. The interpretation of the galactic line-shift discovered by Hubble as an expansion (which can hardly be doubted from a theoretical point of view), leads to an origin of this expansion which lies "only" 10^9 years ago, while physical astronomy makes it appear likely that the development of individual stars and systems of stars takes considerably longer. It is in no way known how this incongruity is to be overcome.

I further want to remark that the theory of expanding space, together with the empirical data of astronomy, permits no decision to be reached about the finite or infinite character of (three-dimensional) space, while the original "static" hypothesis of space yielded the closure (finiteness) of space.
{First published in 1952}

Poetry

Remembering Hart Crane by Malcolm Cowley



Some years ago in the *New Republic*, I told how Hart Crane used to write his poems. But since the poems are still being read, nine years after his suicide, in April, 1932, and since the meaning of his life is still being argued about, the story is worth repeating in more detail.

There would be a Sunday afternoon party on Tory Hill, near Patterson, New York, in Slater Brown's unpainted and un-remodeled farmhouse. I can't remember any of the jokes that were made, or why we laughed at them so hard; I can remember only the general atmosphere of youth and poverty and

high spirits. Hart would be laughing twice as hard as the rest of us in the big, low-ceilinged kitchen; he would be drinking twice as much hard cider and contributing more than his share of the crazy metaphors and overblown epithets. Gradually he would fall silent and a little later we would find that he had disappeared. In lulls that began to interrupt the laughter, now Hart was gone, we would hear a new hubbub through the walls of the next room the phonograph playing a Cuban rumba, the typewriter clacking simultaneously; then the phonograph would run down and the typewriter stops while Hart changed the record, perhaps to a torch song, perhaps to Ravel's "Bolero." Sometimes he stamped across the room, declaiming to the four walls and the slow spring rain.

An hour later, after the rain had stopped, he would appear in the kitchen or on the croquet court, his face brick-red, his eyes burning, his already iron-gray hair bristling straight up from his skull. He would be chewing a five cent cigar which he had forgotten to light. In his hands would be two or three sheets of typewritten manuscript, with words crossed out and new lines scrawled in. "Read that," he would say. "Isn't that the *grrreatest* poem ever written!"

We would read it obediently, Allen Tate perhaps making a profound comment. The rest of us would get practically nothing out of it except the rhythm like that of a tom-tom and a few startling images. But we would all agree that it was absolutely superb. In Hart's state of exaltation there was nothing else we could say without driving him to rage or tears.

But this story, which I have told before, contains neither the real beginning nor the real end. I later discovered that Hart would have been meditating over that particular poem for months or even years, scribbling verses on pieces of paper that he carried in his pockets and meanwhile waiting for the moment of pure inspiration when he could put them all together. In his patience he reminded me of another friend, a famous killer of woodchucks, who instead of shooting at them from a distance with a high-powered rifle, and probably missing them, used to frighten them into their holes and wait till they came out again. Sometimes when they were slow about it, he said that he used to charm them out by playing his mouth-organ. In the same fashion, Hart tried to charm his inspiration out of its hiding place by drinking and laughing and playing the phonograph.

As for the end of the story, it might be delayed for several weeks. Painfully, perseveringly and dead sober Hart would revise his new poem, clarifying its images, correcting its meter and searching through dictionaries and thesauruses for exactly the right word. "The seal's wide spindrift gaze toward paradise," in the second of his "Voyages," was the result of a search that lasted for several days; I was then working in the same office and can remember his roar of jubilation when he found the word "spindrift" in Webster's Unabridged. Even after the poem had been completed, the manuscript mailed to Poetry or the Dial and perhaps accepted, he would still have changes to make. In the formal sense, he was badly educated, having left high school before he was graduated and having filled his head since then with an assortment of sometimes profound but uncoordinated knowledge. He was not even very intelligent, in the conventional sense of the word; as a problem-

solving animal he was less than competent. But nobody I knew, and very few people in the history of literature, were willing to spend so much time in perfecting a single poem to the moment of what seemed to be absolute Tightness.

Four Poems by Hart Crane

Carmen de Boheme

Sinuously winding through the room
On smokey tongues of sweetened cigarettes, --
Plaintive yet proud the cello tones resume
The andante of smooth hopes and lost regrets.

Bright peacocks drink from flame-pots by the wall,
Just as absinthe-sipping women shiver through
With shimmering blue from the bowl in Circe's hall.
Their brown eyes blacken, and the blue drop hue.

The andante quivers with crescendo's start,
And dies on fire's birth in each man's heart.
The tapestry betrays a finger through
The slit, soft-pulling; -- -- -- and music follows cue.

There is a sweep, -- a shattering, -- a choir

Disquieting of barbarous fantasy.
The pulse is in the ears, the heart is higher,
And stretches up through mortal eyes to see.

Carmen! Akimbo arms and smouldering eyes; --
Carmen! Bestirring hope and lipping eyes; --
Carmen whirls, and music swirls and dips.
"Carmen!," comes awed from wine-hot lips.

Finale leaves in silence to replume
Bent wings, and Carmen with her flaunts through the gloom
Of whispering tapestry, brown with old fringe: --
The winers leave too, and the small lamps twinge.

Morning: and through the foggy city gate
A gypsy wagon wiggles, striving straight.
And some dream still of Carmen's mystic face, --
Yellow, pallid, like ancient lace.

Forgetfulness

Forgetfulness is like a song
That, freed from beat and measure, wanders
.Forgetfulness is like a bird whose wings are reconciled,
Outspread and motionless, --

A bird that coasts the wind unwearyingly
Forgetfulness is rain at night,
Or an old house in a forest, -- or a child.
Forgetfulness is white, -- white as a blasted tree,
And it may stun the sybil into prophecy,
Or bury the Gods.

I can remember much forgetfulness.

Exile

My hands have not touched pleasure since your hands, --
No, -- nor my lips freed laughter since 'farewell',
And with the day, distance again expands
Voiceless between us, as an uncoiled shell.

Yet, love endures, though starving and alone.
A dove's wings clung about my heart each night
With surging gentleness, and the blue stone
Set in the tryst-ring has but worn more bright.

The Broken Tower

The bell-rope that gathers God at dawn
Dispatches me as though I dropped down the knell

Of a spent day - to wander the cathedral lawn
From pit to crucifix, feet chill on steps from hell

Have you not heard, have you not seen that corps
Of shadows in the tower, whose shoulders sway
Antiphonal carillons launched before
The stars are caught and hived in the sun's ray?

The bells, I say, the bells break down their tower;
And swing I know not where. Their tongues engrave
Membrane through marrow, my long-scattered score
Of broken intervals ... And I, their sexton slave!

Oval encyclicals in canyons heaping
The impasse high with choir. Banked voices slain!
Pagodas campaniles with reveilles out leaping-
O terraced echoes prostrate on the plain! ...

And so it was I entered the broken world
To trace the visionary company of love, its voice
An instant in the wind (I know not whither hurled)
But not for long to hold each desperate choice.

My world I poured. But was it cognate, scored
Of that tribunal monarch of the air
Whose thighs embronzes earth, strikes crystal Word
In wounds pledges once to hope - cleft to despair?

The steep encroachments of my blood left me
No answer (could blood hold such a lofty tower
As flings the question true?) -or is it she
Whose sweet mortality stirs latent power?-

And through whose pulse I hear, counting the strokes
My veins recall and add, revived and sure
The angelus of wars my chest evokes:
What I hold healed, original now, and pure ...

And builds, within, a tower that is not stone
(Not stone can jacket heaven) - but slip
Of pebbles, - visible wings of silence sown
In azure circles, widening as they dip

The matrix of the heart, lift down the eyes
That shrines the quiet lake and swells a tower...
The commodious, tall decorum of that sky
Unseals her earth, and lifts love in its shower.

American Beauty – a mixed drink


a BRANDY COCKTAIL for men
by james montgomery flagg
AMERICAN BEAUTY
½ oz. brandy
½ oz. dry vermouth
½ oz. grenadine
½ oz. orange juice
Dash white creme de menthe
Shake well with cracked ice,
and strain into cocktail glass.
JAMES MONTGOMERY FLAGG
From BOTTOMS UP, copyright 1951 by Ted Saucier, published by Greystone Press.

Le Bestiaire par Guillaume Apollinaire

Orphée



Admirez le pouvoir insigne
Et la noblesse de la ligne :
Elle est la voix que la lumière fit entendre
Et dont parle Hermès Trismégiste en son Pimandre.

Admire the badge of power
And the nobility of the line:
She is the voice that the light made heard
And of which Hermes Trismegistus speaks in his Pimandre.

La Tortue



Du Thrace magique, ô délire!
Mes doigts sûrs font sonner la lyre.
Les animaux passent aux sons
De ma tortue, de mes chansons.

Magical Thrace, O delirium!
My sure fingers sound the lyre.
Animals stop to listen to the sounds
Of my turtle lyre and of my songs.

Le Cheval



Mes durs rêves formels sauront te chevaucher,
Mon destin au char d'or sera ton beau cocher
Qui pour rênes tiendra tendus à frénésie,
Mes vers, les parangons de toute poésie.

In my deepest dreams I will know how to ride you,
My destiny in the gold chariot will be your wonderful coachman
Who will hold your reins stretched to frenzy,
My verses, the paragons of all poetry.

La Chèvre du Thibet



Les poils de cette chèvre et même
Ceux d'or pour qui prit tant de peine
Jason, ne valent rien au prix
Des cheveux dont je suis épris.

The hair of this goat, and even
that of gold for which Jason made such an effort,
is worth nothing when compared to the value
of the hair with which I am in love.

Le Serpent



Tu t'acharnes sur la beauté.
Et quelles femmes ont été
Victimes de ta cruauté!
Ève, Eurydice, Cléopâtre;
J'en connais encor trois ou quatre.

You are obsessed with beauty.
And what women have been
Victims of your cruelty!
Eve, Eurydice, Cleopatra;
I still know three or four of them.

Le Chat



Je souhaite dans ma maison:
Une femme ayant sa raison,
Un chat passant parmi les livres,
Des amis en toute saison
Sans les quels je ne peux pas vivre.

I wish in my house:
A woman having her reason,
A cat passing among the books,
Friends in all seasons
Without which I cannot live.

Le Lion



O lion, malheureuse image
Des rois chus lamentablement,
Tu ne sais maintenant qu'en cage
A Hambourg, chez les Allemands.

O lion, unhappy image
Such a sad fallen kings,
You now only know a cage
In Hamburg, among the Germans.

Le Lièvre



Ne sois pas lascif et peureux
Comme le lièvre et l'amoureux.
Mais que toujours ton cerveau soit
La hase pleine qui conçoit.

Don't be lascivious and fearful
Like the hare and the lover.
But always let your brain be
Free to run about.

Le Lapin



Je connais un autre connin
Que tout vivant je voudrais prendre.
Sa garenne est parmi le thym
Des vallons du pays de Tendre.

I know another damned animal
That while alive I would like to take.
His warren is among the thyme
Valleys of the land of Tendre.

Le Dromadaire



Avec ses quatre dromadaires
Don Pedro d'Alfaroubeira
Courut le monde et l'admira.
Il fit ce que je voudrais faire
Si j'avais quatre dromadaires

With his four dromedaries
Don Pedro of Alfaroubeira
wandered throughout the world and admired it.
He did what I would wish to do
if I had four dromedaries.

La Souris



Belles journées, souris du temps,
Vous rongez peu à peu ma vie.
Dieu! Je vais avoir vingt-huit ans,
Et mal vécus, à mon envie.

Beautiful days, mice of time,
You are eating away at my life little by little.
God! I'm going to be twenty-eight …
Having badly lived but to my liking.

L' Éléphant



Comme un éléphant son ivoire,
J'ai en bouche un bien précieux.
Pourpre mort!… J'achète ma gloire
Au prix des mots mélodieux.

Like an elephant its ivory,
I have a precious good in my mouth.
Purple dead!… I buy my glory
At the cost of melodious words.

Orphée



Regardez cette troupe infecte
Aux mille pattes, au cent yeux:
Rotifères, cirons, insectes
Et microbes plus merveilleux
Que les sept merveilles du monde
Et le palais de Rosemonde!

Look at this revolting troupe
With a thousand legs, a hundred eyes:
Rotifers, mites, insects
And more wonderful microbes
Like the seven wonders of the world
And the Rosemonde Palace!

La Chenille



Le travail mène à la richesse.
Pauvres poètes, travaillons!
La chenille en peinant sans cesse
Devient le riche papillon.

Work leads to wealth.
Poor poets, let's work!
The caterpillar toiling incessantly
Become the rich butterfly.

La Mouche



Nos mouches savent des chansons
Que leur apprirent en Norvège
Les mouches ganiques qui sont
Les divinités de la neige.

Our flies know songs
What did they learn in Norway
Ganic flies that are
Snow deities.

La Puce



Puces, amis, amantes même,
Qu'ils sont cruels ceux qui nous aiment!
Tout notre sang coule pour eux.
Les bien-aimés sont malheureux.

Fleas, friends, even lovers,
How cruel are those who love us!
All our blood flows for them.
Beloveds are unhappy.

La Sauterelle



Voici la fine sauterelle,
La nourriture de saint Jean.
Puissent mes vers être comme elle,
Le régal des meilleures gens.

Here is the fragile grasshopper,
the nourishment of Saint John.
May my verses be like it:
a treat for the very best people.

Orphée



Que ton cœur soit l'appât et le ciel, la piscine!
Car, pêcheur, quel poisson d'eau douce ou bien marine
Egale-t-il, et par la forme et la saveur,
Ce beau poisson divin qu'est *JÉSUS*, Mon sauveur?

Le Dauphin



Dauphins, vous jouez dans la mer,
Mais le flot est toujours amer.
Parfois, ma joie éclate-t-elle?
La vie est encore cruelle

Dolphins, you play in the sea,
yet the waves are still bitter.
Does my joy ever burst out?
Life is still cruel.

Le Poulpe



Jetant son encre vers les cieux,
Suçant le sang de ce qu'il aime
Et le trouvant délicieux,
Ce monstre inhumain, c'est moi-même

Throwing his ink to the skies,
sucking the blood of what he loves
And finding it delicious,
This inhuman monster is myself.

La Méduse



Méduses, malheureuses têtes
Aux chevelures violettes
Vous vous plaisez dans les tempêtes,
Et je m'y plais comme vous faites.

Jellyfish, unfortunate heads
With purple hair
You delight in storms,
And I like it … like you do.

L' Écrevisse



Incertitude, ô mes délices
Vous et moi nous nous en allons
Comme s'en vont les écrevisses,
À reculons, à reculons.

Uncertainty, Oh my delicacies
you and I, we move about
as crayfish move about
,backwards, backwards.

La Carpe



Dans vos viviers, dans vos étangs,
Carpes, que vous vivez longtemps!
Est-ce que la mort vous oublie,
Poissons de la mélancolie.

In your moats, in your ponds,
carp, how long you live!
Has death forgotten you,
fish of melancholy?

Orphée



La femelle de l'alcyon,
L'Amour, les volantes Sirènes,
Savent de mortelles chansons
Dangereuses et inhumaines.
N'oyez pas ces oiseaux maudits,
Mais les Anges du paradis.

The female of the Halcyon,
Love, the flying Sirens,
know deadly songs
Dangerous and inhuman.
Don't listen to those cursed birds,
Instead listen to the Angels of Heaven.

Les Sirènes



Saché-je d'où provient,
Sirènes, votre ennui
Quand vous vous lamentez, au large, dans la nuit?
Mer, je suis comme toi, plein de voix machinées
Et mes vaisseaux chantants se nomment les années.

Do I know where it comes from,
Sirens, your boredom
When you lament, off, in the night?
Sea, I'm like you, full of engineered voices
And my singing vessels are called years.

La Colombe



Colombe, l'amour et l'esprit
Qui engendrâtes Jésus-Christ,
Comme vous j'aime une Marie.
Qu'avec elle je me marie.

Dove, love and the spirit
Who fathered Jesus Christ,
Like you, I love a Mary.
That I will to marry her.

Le Paon



En faisant la roue, cet oiseau,
Dont le pennage traîne à terre,
Apparaît encore plus beau,
Mais se découvre le derrière.

Cartwheeling, this Peacock,
Whose plumage drags on the ground,
Appears even more beautiful,
But I discover what's behind its feathers.

Le Hibou



Mon pauvre coeur est un hibou
Qu'on cloue, qu'on décloue, qu'on recloue.
De sang, d'ardeur, il est à bout.
Tous ceux qui m'aiment, je les loue.

My poor heart is an owl
My heart opens, it unlock, then relocks.
Such blood, ardor, my poor heart is exhausted.
All those who love me, I praise them.

Ibis



Oui, j'irai dans l'ombre terreuse
Ô mort certaine, ainsi soit-il!
Latin mortel, parole affreuse,
Ibis, oiseau des bords du Nil.

Yes, I will go in the earthy shadow
O certain death, so be it!
Deadly Latin, awful speech,
Ibis, bird of the banks of the Nile.

Le Boeuf



Ce chérubin dit la louange
Du paradis, où, près des anges,
Nous revivrons, mes chers amis,
Quand le bon Dieu l'aura permis.

This cherub speaks praise
From paradise, where, near the angels,
We will live again, my dear friends,
When the good Lord allows it.

Poetry by Guillaume Apollinaire

Le Bestiaire ou Courtège d'Orphée, Paris, 1911

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There is Little of My Soul Left

Dear God,
Forgive me
For I have sinned.

I have loved
in a world filled
full of hate.

I have been gentle
when others really
only want to be mean.

I have tried to create
Heaven on Earth
but it is hell they really want.

I have tried to be kind and strong
but I have been ground
to dust instead.

Dear God,
Forgive me

For I have sinned.

There is little of my soul left
here crushed beneath my cross
and crown of thorns.

A Few Words …

When I am in the mood
I sit and write poetry.

Usually it is
when I am nostalgic
or happy about life
or when I feel romantic
or when I feel troubled.

Then I share
A few words …

Here are some for you!

The Many Things I Love

I compose this poem

as I lie inside an
ambulance as it
speeds me to the hospital.

I am thinking about
the many things I love

The fact that I am still alive
but am getting older with each
beat of my heart.

The fact that I can still walk
having broken my neck as a young man
when I served in the navy
and saved the life of a silly officer cadet!

The fact that I can still talk
Even if no one listens

I love the sun that shines on me
Through a hole in the clouds
as they wheel me into ER

God is saying
Hell
oh …

The facts that I have friends
who love me,
and friends I love in return

The smile of the nurse who takes
my pulse and tells me earnestly
'You will be fine!'

Frankly … I don't believe her
Otherwise I wouldn't be here
would I … But I smile back.

If only my old heart loved
the many things I love,
Then I would love this moment too!

It's so Unbearable

Spring is here!
Or so that's what the calendar says,
I fear the calendar's all wrong!

It says it is April
But it feels more

like January.

It hailed yesterday
It snowed today
It will rain tomorrow
All day and into the next.

Even Sunday doesn't
stay true to its name

It's so unbearable
I want to hibernate!

Wake me up
If summer ever comes.

Are our Lives an Oxymoron?

It's our *only choice*
for sure …
an *open secret* that
each day we must
trudge, trudge, trudge
off to work!

Is this the meaning of our lives?
Isn't it forty two?
But what is the question?

Isn't it … why we trudge
to work. Here's a clue
forty-two in binary is
I O I O I O …

It's off to work we go.

OMG …
Such *deafening silence*!
Are our lives an oxymoron?
… are we *the living dead*?

There are Minotaur amongst us

Come save us … Salvador
As we dili and dali
The world has once again
become Monsterous …

Brothers kill brothers, and sisters too,
and little babes as they wait for their choo choos

to take them to safe haven.

Little angels unknowing
what sins abound about them
who get their wings far … far … far
too early as we bury them
In their loving mother's arms

The world is once again
DaDa … so horrific
So surreal!

There are Minotaur amongst us
we better all run and hide
before they eat us all alive!

Heh …Throw us a few Coins!

Almost everyone loves poetry
But darned if they'll recompense
The poet for their toil

Almost everyone has their favorite
Poet, perhaps even one who still lives
Who they walk past in the street

Not noticing their begging bowl
Not recognizing their dignity
Nor their poverty!

It is not that the poet
Will turn away your generosity
It's just …just .. its

that you just ain't generous
to begin with

Heh … throw us a few coins!

He Loves Alone

A Catholic man
in his sixties
hope to be a father.

He lives alone
since his divorce
many years ago.

He has women friends

who know of his hope.
They tell him, do not
give up hope.

They look to younger men;
youth may have beauty
but not wisdom.

He has wisdom
and looks like Henri Matisse.

So he takes to painting
to create his children,
one brush stroke at a time.

The women can sense
his kindness and gentleness
in his art.

He is making love to them
with his paint brush.
Still they stay away.

He loves alone.

Take the High Road – Few Souls Will Follow You There

I know not how to start the tale
nor how to end it. Perhaps it will
end itself in time. It leaves me pale
to think of it. It leaves me ill
at heart. Take the high road –
few souls will follow you there,
Take the low and your mood
will be crowded out. Care
that you do not trip up
for the vultures will start
to circle, they'll gather to sup,
hoping to tear you apart.
They'll throw you over
the first chance they get
and leave your bones
to blanche in the sun

You Remind Me of Victor Hugo

I have a friend
who is a sculptor.
He struggles just like me
He studies me and says

you remind me of Victor Hugo.
sit – let me do your bust,
but leave your hat on!
I want to sculpt something different.
A bust with a hat on is novel!
No, Victor Hugo never wore hats.
Like him you like to write stories.
Maybe one day he will be
famous, my artist friend
and his art will make
me famous too. Or maybe
we'll both just go bust!
Two artists who struggled
And now are forgotten.

Something Pink and Flower Like

I try to imagine
how she might look.
How her petals might
curl like something
pink and flower like.
How she is plentiful
and would put Andromeda
to shame. The summer

is young – the sun
it has begun to shine.
The days are bright
They might get hotter
still. The dew might
flow and fill the air
with that indescribable
perfume that draws
us to savour the softness
of something that is
pink and flower like
Oh how the tulips
Blossoms.

Is it the Dark Abyss of Death You Fear?

While the dawn cometh before us, we face
the dusk differently, knowing much more
then when our task was 'take a first breath!" Graced
by an unknowing and terrifying journey, before
we understood ourselves and the world – now
things are much different. We have grown old …
time had passed in its mortal toll. How
much we regret, those tasks left undone, told we –
leave it until tomorrow. Well, it has come –

the morrow, and the sorrow, time cannot be overturned.
Let the clocks run down, look nought in a mirror!
That inevitable, unhappy friend cannot be spurned,
And is it the dark abyss of death you fear,
or is it growing old and frail, my dear?

Watching the Women Walk By

The soft lap… lap… lap …
of the water
reminded me of the soft
frap … frap … frap …
of a woman, enjoying herself.

Until the roar of a speedboat
made me think of a machine
with batteries, and then
the din … dimmed into a hum
then back to …

The soft lap… lap… lap …
frap … frap … frap …
of the grand ocean waves lapping and
frapping upon the shore.
I was waiting for my women friends.

It was high tide –
the moon was overhead
dusk … and here I was
all alone on a bench
watching the women walk by.

Waiting for the sky to darken
And the stars to light up the heavens …
Waiting for Cassiopeia, Virgo and
Andromeda to come
To keep me company.

Science and Technology

Anchored in the Solar System: An Interview with Jim Lovell

Captain James A. Lovell, Jr., U.S. Navy (Retired)

December 1995
USNI Proceedings
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> *The recipient of the Congressional Space Medal of Honor talked recently with Naval History Editor Fred Schultz and Proceedings Associate Editor Bruce Gibson about the space program in general, the Apollo 13 mission—subject of the popular summer 1995 motion picture starring Tom Hanks as Jim Lovell—and the future of space exploration.*

Proceedings: As a Naval Academy graduate, what advice do you give future naval officers who want to go into the space program?

Captain Lovell: When I entered the program, we all had questions about being sidetracked into a quasi-government program that would have nothing to do with naval traditions or naval promotions. I think naval officers ought to have certain experiences and foundations to be career officers, especially if they are going to defend their country.

Having said that, I didn't have many of those, because I went into the space program. But naval officers tend to go into varied fields—more so, I think,

than Army officers. And many naval officers are in government or some aspects of government, and do other things besides command ships. NASA has expanded into several disciplines now. You don't have to be a test pilot anymore. In fact, only two people command the space shuttle itself. All other people are mission specialists of some sort. Several of our astronauts were really not pilots, per se, but were mission specialists. We've even had civilians come in as payload specialists. So I think the space program is still a very viable field and a great career.

I think people who choose naval aviation take on a certain amount of risk, and there is certainly an element of risk in the space program. I don't think it's as great as it once was. The shuttle today is much like getting on an airliner. Occasionally, though, accidents do happen.

Proceedings: What do you think the space program could do differently to attract young people?

Captain Lovell: I think NASA has consistently been accused on doing a poor marketing job. People ask, "Why are we still sending people into space? What benefit did we get from the Apollo program? Why did we spend all that money away from the earth?" Well, in actuality, we spent all the money on the earth. But that message has not come across well. I think NASA should emphasize the advantages of having an active U.S. space program.

Right now, we are no longer threatened by the great Evil Empire, and to some degree that's bad news for us who try to justify space travel. Keeping up with the Soviets was a great incentive. It was intense competition, and we love competition. As a matter of fact, we were underdogs for a long time. In reality, that was a good thing, because it spurred our Apollo program.

But we don't have that now. What we do have, however, is cooperation. Several countries are knitted together with the common goal of an international space station. We have a method of communication among countries on a subject surrounded by little or no controversy. Many questions remain, of course—how big it should be and who should spend the money—but it's not that controversial. And such exchanges create a rapport and lay the groundwork for interaction between countries in other fields, because a camaraderie has already been established, without boundaries. Those are intangible benefits of an active space program that Congress sometimes misses when the time comes to approach funds year by year. Our lawmakers fluctuate, depending on which way the winds are blowing politically, without really looking at the big picture. The space program yields intangible benefits, and that story needs to be told.

Proceedings: It seems that our new relationship with Russia has not been publicized as much as some of the other aspects of the space program. Why would you say that is?

Captain Lovell: Certainly, docking with the Mir was a very important milestone for NASA, but it was not a milestone in the eyes of the American

public like landing on the moon. This is earth orbital. We've been doing earth orbital stuff since Mercury and Gemini, and we've had more than 70 shuttle missions now.

We have to realize that this program, like most programs, has matured. The Russians have a tremendous amount of talent. They spent most of their money in the past either in space or on the military, to the detriment of everything else. So it would be foolish not to tap their experience and knowledge. And if we're going to spend a lot of money to help them, we ought to get something back for it.

As for publicity and exposure, it's just a matter of time. The more things we do together, the more stories about them will find their way into the papers. Knowledge will ultimately get back to the public, which I think will be more responsive.

Because of the book [Lost Moon (New York: Houghton Mifflin Co., 1994] and, more so, the movie ["Apollo 13"], I found out just recently that the silent majority in this country, the people who obviously don't write to their congressmen, are in favor of the space program.

A lot of people I talk to now weren't even born when I flew. Anybody younger than 25 years old wasn't around for Apollo 13. But I find they still are interested. They learn about it in school. A perfect and very visible example is a guy by the name of Tom Hanks. He was a closet astronaut. He really wanted to get into space, knew the names of all the astronauts, all the

space flights. When he finally got in the acting business, he wanted to play an astronaut. He finally got his chance.

Proceedings: President John F. Kennedy's rallying cry to land on the moon seemed to unite all Americans in that pursuit. If the same challenge were set forth today regarding Mars, for example, what do you think the ultimate response would be?

Captain Lovell: Well, in reality, it was set forth. Back on the 20th anniversary of Apollo 11 in Washington, President [George] Bush did set somewhat of a goal for going to Mars. But it was not the same rallying cry that President Kennedy had made. I'm fully convinced Kennedy made that statement because of the political situation he faced at that particular time. The Soviet Union obviously had an edge on us scientifically, and we were asking ourselves why we didn't have an educational system that produced people who could do what the Russians were doing.

So President Kennedy had to make a very bold move, and this was one way he saw that he could do it. It really is a shame that he did not live to see his goal accomplished. I think he probably had doubts that this would actually come to pass, but in 1961 he had to give Americans something to look forward to, a goal that would be unique.

Proceedings: It may take a political competitor to get us in that mind-set again.

Captain Lovell: We also need a Congress and public that say this is what we ought to do. Nothing today would prevent us from going to Mars, nothing technical, at least. The Russians have had people in space now for well over a year, working out the procedures to keep the people healthy, but not so much to go to Mars; it's to come back to the earth and live under the influence of gravity again.

But all it takes is effort, time, and money to do the job. All the systems active today can be used to go to Mars.

Proceedings: We just need the check.

Captain Lovell: Yes, we need the money and the will to do it. Right now, we're concentrating on the space station, which has, I think, important applications in the diplomatic as well as the technical arena.

Proceedings: Two schools of thought seem to prevail concerning the future of space exploration. Some say that, since we've been to the moon, we should focus our efforts more outward to other planets. Others say there is more to do on the moon, specifically, that we should land on the moon again to gain public support to go elsewhere. We have also heard discussions of colonizing the moon. What are your thoughts on that?

Captain Lovell: The studies I've seen indicate that the moon can possibly be used as a training base for a Martian mission. Which of the two schools of thought has more merit depends on what set of scientists you listen

to. Geologists were very disappointed when Apollo 18 and 19 were canceled. Some people in NASA, basically the engineering types, wanted to cancel the program after Apollo 11.

Then there are the scientists who say that we have to find out more about the solar system and do probes to the other planets, and to the satellites of other planets. These two groups are at odds, and many of the differing opinions involved robotics. "We don't need people for these missions," some say. "Let's concentrate our existing funds on unmanned, robotic systems. Then if we lose them, it's not a traumatic situation."

That argument will continue. We'll probably reach a compromise at some point. I think we will go back to the moon, but not before the next century. Right now, the only way we can sell Congress is to show a return on the investment. This is how the shuttle came into being. Originally, it was only one part of a two-pronged space effort; one was the shuttle and the other was the space station. The shuttle was merely the transportation device to travel to the space station. At that time, Congress was not about to fund two programs, so our lawmakers elected to build the shuttle first and the space station later.

The time for the space station has come. From a macro position in space, we will learn more about the earth and bring a quicker return on the investment. A lot of people cannot understand the point of going to the moon. We brought back moon rocks, and 20-some years later we are examining them, trying to

figure out what we have. They probably raised as many questions as they answered. It's amazing.

Proceedings: During the Apollo 13 mission, you must have experienced a feeling of detachment from earth, which would certainly be inevitable on a mission to Mars. Do you think the phenomenon will be a factor in such far-flung missions?

Captain Lovell: I don't really believe that to be as much of a problem as a lot of people have surmised. I recall flying an F8U before I got to NASA. For the very first time we were wearing the early Navy pressure suits that would inflate if we lost pressure above 50,000 feet. The Navy psychiatrists at that time started doing studies on detachment. They concentrated on what happens above 50,000 and 60,000 feet. Would you suddenly feel detached from the earth, much like a diver who experiences rapture of the depth and doesn't realize how long he's been down—or which way is up—and suddenly either doesn't care or gets so enamored with what's going on that he forgets the situation?

Well, nothing like that ever happened flying airplanes. Then we started going into earth orbit. NASA, among other things, had a lot of faith in psychiatrists. They invited several to interview us after we came back from our flights. They would send the psychiatrists out to the ship, and as soon as we came on board they would start interviewing us subtly to see if we had any problems. I can recall one instance after Gemini 12, when I was in the wardroom having lunch. A psychiatrist was sitting directly across from

me. By this time, with my two flights, I had logged 440 hours, which was more time in space than anybody in the world. So I happened to know why this fellow was watching me. Myself, I was just happy to be back on earth. As I was explaining some of the things we did and saw, I had one of those heavy Navy wardroom forks in my hand. I waved it up in the air—and left it up there. I had done that for 440 hours.

Proceedings: It didn't stay there, did it?

Captain Lovell: No! It came crashing down onto the table. You should have seen the eyes of the psychiatrist. Boy, they really lit up. But he had a smile on his face. He'd finally found something to report.

We never really experienced anything I would refer to as detachment in earth orbit. We never felt any detachment in my two flights to the moon. On Apollo 8, up to when we cut the engine and were anchored to the moon, we did hope, in the back of our minds, that the engine would fire again. Otherwise, we would have been a satellite of the moon—permanently. But that's the risk you take. It's no different from being launched off an aircraft carrier and you get a cold cat shot.

I don't think detachment will be a factor in going to Mars. Based on time, the size of the ships, and how acclimated one can get to life in space, missions to Mars or Venus and other solar system trips will be possible. Of course, you can't land on Venus, but you can go around it. You'd never be able to get to the nearest star, which is Alpha Centauri—four light years away. If ever we

can figure out how to travel 186,000 miles a second, it would take us four years to get there.

Proceedings: We're not at Star Trek yet.

Captain Lovell: That's right. Einstein said that, as time slows down, mass increases. If we ever got a chance to come back, the earth would have changed millions of years. Nothing would be the same. So I think we're anchored here in the solar system.

Proceedings: Getting back to robotics, what role will humans play in the future? Can we do it all with robotics?

Captain Lovell: We can do a lot with robotics, no doubt about it. In fact, I think the Naval Research Lab is making a very simple, inexpensive probe for either the moon or Mars. But I don't think anyone has developed a computer as inexpensive and complicated as the human brain. When things don't work as they're supposed to work, as happened on Apollo 13, human beings are still part of the loop and are very, very important.

I don't think we'll ever lose the human desire for adventure and exploration into the Last Frontier—space. People are going to be there whether it's financially expedient or not or whether it's worthwhile or not.

Proceedings: Without that excitement, getting public support will be a challenge.

Captain Lovell: Yes, without people involved, the public doesn't get much enamored with the program.

Proceedings: Were you aware that people on earth were hanging on every report on what you guys were doing in Apollo 13?

Captain Lovell: No. We got our communications strictly through the capsule communicator. Even when we landed, the recovery ship had been out to sea for about a week. Not until we got back to Hawaii did the tremendous impact of this flight begin to dawn on us. Of course, I made one of the traditional goofs. We were on vox—hot mike—when I said, "It will be a long time before we have another moon mission," or something to that effect.

Of course, it took the poor administrator a couple of days to convince the news media that, "what he really means is…" When I got back, I was confronted with the same thing; that was always the first question.

Proceedings: The film "Apollo 13" should impel a lot of excitement—not short-lived excitement, let's hope—with the public.

Captain Lovell: Even though I was worried at first, I was happy with the way it turned out. Ron Howard did a great job of directing. When he approached me about doing a movie based on the book, I told him that the ABC television network produced a docudrama in 1971 called, "Houston, We Have a Problem." They used Apollo 13 as a backdrop, but they focused on four

fictitious flight controllers. That was the main story. One of them had marital troubles, one of them had child-support problems, one of them had a heart attack, and the fourth one's grandfather died.

I told them they ruined a good story. It had nothing to do with Apollo 13, even though the real story had all the drama required to make a good TV program. They didn't have to make up that stuff. I wrote scathing letters to ABC and to NASA for allowing them to use the facilities. When Ron Howard approached me, I told him to look at the ABC program first. "If you're going to do the same thing," I said, "forget me, because I don't want to be any part of it."

Proceedings: The big question for many viewers was, "If I know how it ends, how can I stay interested?"

Captain Lovell: He did a great job of keeping the suspense going, and all the incidents in that movie are true. He didn't have to hype anything. His main job, his main concern, was, "What do I throw out?" When he did the first edit, he had a four-hour movie. Universal said, "No way are we going to have a four-hour movie." So he got it all down to a two-hour-and-15-minute movie. That's why I tell people that they'll appreciate the movie more if they read the book first.

Proceedings: As far as the general public is concerned, do you have any concern that the movie itself will become the historical record?

Captain Lovell: Well, there's always that chance, just like the movie "Patton." When you think of General George Patton, what image comes to mind? George C. Scott, right? I've kidded Tom Hanks, saying, "Look, you'd better start learning how to write my name, because when all these photographs come for signatures, I'm sending them to you."

To answer your question, if it has positive results, a positive influence, I couldn't care less.

Proceedings: At least the story is out there.

Captain Lovell: The true story is out there. That's the reason why I wrote the book. I was very fortunate to get a great co-author, Jeff Kluger, who had never written a book before. I had never written one, either. We both wrote technical journals, but he worked for Discover magazine and had a degree in journalism. He wrote to me to say he wanted to write a book on Apollo 13. I said that I wanted to do it, too, and that we should do it together. That's how it came to pass.

Proceedings: In the book, you and Mr. Kluger give high praise to Jules Bergman at ABC News for going through some of the training that the astronauts went through and for being empathetic to what it was you were doing. What did you think of the general news coverage back then, and what do you think of it now in comparison?

Captain Lovell: I thought the news coverage in those days was very positive. My wife Marilyn won't give the same accolades to Jules Bergman, only because he was, after all, a newsman. Apollo 13 was Doomsday for Jules—only a 10% chance of getting back, the whole business. But he did go through all the training to be fully up to speed. Marilyn would rather have listened to Walter Cronkite, who had a more fatherly approach to everything.

I think they're covering it pretty well today, too. But you have to realize that human nature says that repetition means people get complacent, and people got complacent about Apollo 13. This was the third lunar-landing mission, but none of the networks carried it. The movie showed some of the subtle things—guys yawning, one of the guys looking at the baseball game on the side. They were all waiting to shut down for the night, because we were going to go to sleep. It was just another day at the office.

Today, with more than 70 shuttle flights, I don't think one network carries shuttle launches. Maybe CNN does, because they think they have an "in" if something goes wrong. For the Challenger accident, they were right there. If something unique happens, like the Mir docking, they will cover it. And that was, I think, adequately covered. The Hubble telescope repair also got some coverage. These are all great events. The public just doesn't understand. It was the same way with Apollo 13. For many years people did not appreciate what really went on to get the spacecraft back home again. I think a lot of people don't understand the successful docking between an ancient space station and a shuttle, or the repair of a telescope out in space, or the capture of

a satellite. Again, these are good examples of humans taking over when robots were incapable of getting the job done.

Proceedings: Do you think we have too many scientists and not enough aviator types? Do the astronauts today, pardon the phrase, have the "right stuff?"

Captain Lovell: I wouldn't want to separate between scientists and aviators. I think the people who go into the program—whether they are geologists, physicists, doctors, or pilots—all need a certain amount of adventuresome, risk-taking spirit. They've got to be pioneers, regardless of what their discipline is. We don't need people who know just how to fly airplanes. We do need people who can adapt to an ancient Mir space station and to eating Russian food. They've got to learn to be survivors.

Proceedings: It's our custom to give our interviewees a parting shot. Here's your chance to address anything we have not covered.

Captain Lovell: I have a couple of things. Number one is the fact that I am very proud to be part of the naval establishment. I think the Navy in all aspects has provided a foundation for space activities in this country. I think our space program, however it forms in the future, will be an important factor in the overall operation of this country.

NASA has the ability to create new technologies. It creates new industries and new products. And it is very much a diplomatic tool.

I recall vividly, when Sputnik was launched, the great outcry questioning why we did not have an adequate system to do the same thing. It was that way for a long time. I think the majority of the people today feel that NASA still plays an important role in the U.S. government's efforts to keep this country a leader. So I hope Congress realizes that, and the administration realizes that, so they can stop quibbling year in and year out and vacillating so much that we don't have a clear direction for what we should be doing in the future.



Capt. Jim Lovell in front of Apollo 10 spacecraft

Two Elements For One - Scientific American (October, 1939)

The Most Important Scientific Discovery of the Present Year is also the Biggest Explosion in Atomic History ... Splitting the Uranium Atom

The Fifth Washington Conference on Theoretical Physics was sitting in solemn conclave when the news broke. Professor Nils Bohr of Princeton and Professor Enrico Fermi of Columbia rose to open the meeting with an account of some research going on in a Berlin laboratory. Professors Bohr and Fermi are Nobel Prize winners both, and their names are as well known to scientists as Toscaninni's is to music lovers. The Conference therefore expected something extra special. They weren't disappointed.

It was January 26, 1939. A few weeks before, at the Kaiser Wilhelm Institute in Berlin, Dr. Otto Hahn, a distinguished German physicist, had obtained an utterly unexpected result from some more or less routine experiments. Following the original example of Professor Fermi, Dr. Hahn and his co-worker, F. Strassmann, had for many months been bombarding uranium with neutrons and studying the debris left by this atomic warfare.

It would not have surprised them at all to find radium as one of the products. In fact, they had done so before, or thought they had. Radium and uranium are near neighbors in the table of elements, and it is nothing new for scientists to transform one element into another close to it in weight and electric charge.

But it was news, and big news, to discover barium among the debris — barium, which is only a little more than half as heavy as uranium. It meant that the neutron bullets had succeeded not merely in knocking a few chips off the old block, but in blowing the whole atom asunder with a terrific explosion.

The theoretical and practical import of Hahn's discovery may not be immediately obvious to the laymen. The article will attempt to interpret its significance in later paragraphs. But on the scientists, the news had the same effect as the tidings of gold in California had on the Forty-niners. They flew to their laboratories to find the treasure for themselves.

A few insiders had already jumped the gun ahead of the Conference and of the rest who learned of the discovery through the newspapers. In Copenhagen, Dr. O. R. Frisch and Professor Lise Meitner, who had previously worked with Hahn on the same problem, had verified his results ten days earlier. A group of Columbia University physicists, including Fermi, independently thought up and carried out a similar experiment by January 25, the day before the Conference. By the time the meeting wound up its affairs January 28, three more laboratories — at the Carnegie Institution of Washington, Johns Hopkins, and the University of California — joined the chorus of confirmation. In a word, Hahn was right. Uranium, and thorium, too (thorium is also among the heaviest elements), had been split in two by neutron bombardment.

The phenomenon was quickly dubbed “nuclear fission,” and in the months ensuing since its discovery, nuclear fission has grabbed the spotlight from the “heavy electron” sensation of 1937-8. Dozens of the world’s top-flight physicists have been busy as bees, roaming the clover of a new field of research.

The first task of the investigators was to get a picture of what had happened. Dr. Frisch and Miss Meitner promptly supplied a pretty good one.

The nucleus of an element, they pointed out, is now thought of as an aggregation of protons and neutrons packed together into an inconceivably small space. The number of protons, or units of positive electric charge, accounts for the chemical behavior of the element. Neutrons are units of weight and have no charge. Together the neutrons and protons make up the mass of the nucleus. The simplest nucleus is the single proton belonging to the lightest element, hydrogen. Going up the atomic scale, adding one proton and a varying number of neutrons for each successive element, we arrive at last at uranium. This heaviest of elements is invariably characterized by its 92 protons; in its commonest form it contains 146 neutrons as well, giving it a total weight of 238. Two other forms, weighing 235 and 234, also occur in small quantities. These are called the three natural isotopes of uranium, and are distinguished by the shorthand symbols $^{238}U_{92}$, $^{235}U_{92}$, and $^{234}U_{92}$.

Now all the known elements heavier than mercury — that is, thallium, lead, bismuth, polonium, radon, radium, actinium, thorium, protactinium, and uranium — have isotopes that are naturally radioactive. Their nuclei are so

complicated that occasionally one will spontaneously simplify itself by shooting off a particle.

We can picture the process nicely if we imagine for a moment that the radioactive nucleus is like a drop of water, composed of many molecules. One of the molecules near the surface somehow acquires a little more energy than its fellows and evaporates.

The stage is now set to return to Dr. Frisch and Miss Meitner, whom we left some paragraphs ago. Their conception of the nuclear fission process continues the analogy of the drop of water. Suppose the H_20 molecules are violently agitated by a source of energy outside the drop. Instead of evaporating gradually, the drop splits in two. Similarly, a uranium nucleus, stimulated by the impact of a neutron bullet, may divide into two smaller nuclei of roughly equal size.

These fragments are in themselves unstable, and quickly disintegrate to form still other nuclei. In fact, a whole series of transmutations generally follows the fission of uranium or thorium. Since Hahn first found barium among the products, he and other investigators have identified antimony, tellurium, iodine, xenon, cesium, and lanthanum in one group; bromine, krypton, rubidium, strontium, and yttrium in another, with many possible additions.

The explanation is simple enough. The original fragments contain too many neutrons in relation to their proton content, and must get rid of them to achieve a stable form. One of two things happens. The nucleus may simply expel a

whole neutron, reducing its weight by a unit. Or one of the neutrons may be converted into a proton plus a negative electron inside the nucleus, which promptly ejects the electron. In the latter case, the nucleus remains approximately the same weight but acquires an additional positive charge, thus becoming a chemically different element. Experiments have proved that both these types of disintegration actually do take place.

No one knows yet whether the same two original products are always formed when uranium divides, or what they are. But if one of the fragments is barium, with 56 protons, the other must have 92 minus 56, or 36, protons, which would make it an isotope of the gas krypton.

If the barium tries to stabilize itself by emitting an electron, it becomes a lanthanum isotope, which may in turn convert itself into cerium by electron emission. The krypton also disintegrates in the same way, successively becoming rubidium, strontium, and perhaps yttrium and zirconium. We can show these chain reactions by a formula where the sub-scripts represent the number of protons of the products:
Ba56 -> La57 -> Ce58 -> Kr36 -> Rb37-> Sr38 -> Y39 -> Zr.40

Again, if the two original fragments are strontium and xenon instead of barium and krypton, we may have the following chain reactions:

Sr38-> Y39-> Zr40

Xe54 -> CS55 -> Ba56 -> La57 -> Ce58

In a discovery like this in the realm of pure science, it is always easier to see the theoretical importance than to find a practical application. The fission of uranium has provided a field day for the physicists who like to take atoms apart and find out what makes them tick. It adds a new chapter to their knowledge of the nucleus — the forces that hold it together, the collective behavior of its constituent parts, its reaction "under fire," its destiny.

In addition, it clears up a mystery of long standing, dealing with elements heavier than uranium. When, in 1934, Fermi began his experiments with uranium, he soon found that negative electrons were always emitted under neutron bombardment. We know now that they are usually the products of the chain reactions just described; but at that time nuclear fission was not even dreamed of. Fermi naturally concluded that the uranium nucleus captured the neutron, converted it into a proton and expelled an electron.

Here, then, was a supposedly new element with 93 protons, unknown to nature. Moreover, this new element seemed to emit another electron to form another new nucleus of 94 protons. These were called "transuranic" elements, and up until lately they were a headache to the numerous investigators who worked on them. The latter kept finding more and more transuranic; and when they studied their chemical properties they found inexplicable variations. Last November, just a few weeks before Dr. Hahn stumbled on the real secret, he announced that he had found at least 16 different kinds of nuclei resulting from neutron bombardment of uranium. Some of them, indeed, behaved chemically like barium, lanthanum, and other light elements, but they were

thought to be isotopes or isomers of heavier elements such as radium. (Isomers are nuclei having the same total weight but different chemical properties. Isotopes have the same proton content but varying total weights.)

When the announcement of nuclear fission came, it was immediately realized that the electrons were not in general emitted by the uranium nucleus itself but by its lighter fragments. The mystery of "transuranic elements" was practically solved. It does seem, however, that a neutron bullet occasionally fails to give its target quite enough energy to divide; the uranium isotope disintegrates by electron emission and really does form a new element with 93 protons. But one such problem child is far better than 16.

So much for the theoretical significance of nuclear fission, far-reaching though it is. It is pretty hard to amass as much weight on the practical side of the balance. But our imaginations are immediately seized by the terrific amount of energy liberated when a single uranium nucleus explodes. The two fragments fly apart activated by some 200,000,000 electron volts — a total far greater than that associated with any other atomic phenomenon except cosmic rays.

The tabloids love to write of blowing up the world with a gram of matter, and it's not such a sensational idea as one might think. Even a tiny mass has an enormous potential of energy if it could but be freed. It is just such a conversion of mass into energy that speeds the fission fragments on their way.

The weight of any nucleus is never quite equal to the sum of its individual protons and neutrons. A small proportion of their mass, called the “packing fraction” or “mass defect,” is somehow transformed into the force that holds the nucleus together. Otherwise the positively charged protons would all repel each other and scatter in every direction.

The packing fraction for uranium is, because of its large number of particles, greater than that for the simpler elements into which it divides. This difference in energy is released with the two fission fragments.

OF course, 200,000,000 volts is an astounding energy compared with the size of the bodies which possess it. But for practical purposes it is absurdly small, amounting only to about three ten thousandths of an erg. In more everyday terms, it would take 25,000 billion fissions per second to produce one horsepower — figures which dwarf even the national budget. The very best a laboratory can do so far is produce a few hundreds per second.

If atom smashing could be made more efficient, power production by means of nuclear fission would not be beyond the realms of possibility. But under present conditions, the process is as inefficient as removing the sand from a beach a grain at a time. Or, more graphically, it is like shooting with buckshot at a network of beads strung yards apart. The size of the target is comparable with the size of the projectile, the empty space between targets is enormous compared with the diameter of either, the stream of bullets cannot be well controlled or aimed, and therefore it is much more probable that the neutron

projectile will fly past a uranium nucleus than to score a direct hit and be captured. In fact the chances are thousands to one against fission taking place.

Neutrons have proved themselves more efficient atom-busters, however, than other projectiles like protons or alpha particles, which are positively charged and hence repelled by the positive nuclei. To get a stream of neutrons, a preliminary bombardment must take place. One common method employs the radioactive gas radon, which spontaneously emits alpha particles (helium nuclei with double charge and mass four). The alpha particles are allowed to fall on a sheet of beryllium, where they join with the beryllium nuclei to form carbon plus neutrons. The reaction is shown by the formula:

$^{9}Be_{4} + {}^{4}He_{2} \rightarrow {}^{13}C_{6} \rightarrow {}^{12}C_{6} + {}^{1}n_{0}$

where the superscripts are the atomic weights and the subscripts the charge.

The stream of positive particles from the cyclotron may also be used to bombard beryllium and thus produce neutrons. The high energy and great number of cyclotron particles make them more efficient neutron makers than the natural radio-alpha particles.

Once created, the neutron beam is directed against a uranium target. The products are studied in various ways. If the investigators want to find the energy of the fragments, the target is placed in an ionization chamber, filled with a gas at low pressure. The fragments rip through the gas atoms, disrupting their outer electron structure to form ions. The gas ions are drawn to a wire

where they constitute a tiny electric current, and the magnitude of this current gives a clue to the energy of the fission products.

If the experimenters want the range of the particles — that is, the distance they travel before their kinetic energy is all used up — they may choose a Wilson cloud chamber which automatically photographs the track of ions the nucleus leaves behind it.

If they want to know the number of fissions occurring in a given time, they have an electric counter at their command, based on the same principle as the ionization chamber. A modification of the same instrument is used to look for electrons or neutrons emitted in the fission process or in the chain reactions that follow.

The problem of identifying the products is a somewhat different one, and is complicated by the large number of elements which may be formed. Here the debris is collected on a sheet of Cellophane or paper placed close to the uranium target. Each variety of isotope on the sheet has a definite rate of disintegration — it may be anywhere from a fraction of a second to several days — and this time is characteristic of the element to which the isotope belongs.

To measure this period of decay, the collecting paper is placed near an electric counter. If the activity of one product decays to half its original value in 87 minutes, for example, that product is immediately known as an isotope of barium, $^{139}Ba_{56}$, which is known from other experiments to have a characteristic "half life" of 87 minutes. The difficulty of this method of

identification is, of course, in separating the half-live when two or more elements are decaying together; and also in classifying a half-life belonging to an isotope previously unknown.

Another method of studying the products is to perform the experiment under water, then analyze the water chemically. Suppose we suspect that a few nuclei of radioactive lanthanum are present. This is too small a quantity to separate directly. But if a larger amount of a stable lanthanum compound is added to the water, both stable and un-stable lanthanum atoms can be precipitated out. If this precipitate is then shown to be radioactive, we have proved our suspicion was correct. Similarly the water can be tested for radioactive barium by adding a stable barium compound and so on.

Still a third attack on the problem of identification has been made by Philip Abelson at the University of California. He had been studying the natural X rays from the supposed "transuranic elements"; and put on the right track by the discovery of nuclear fission, he quickly showed that these X rays had wavelengths characteristic of iodine and tellurium.

Research along all these lines is proceeding at breakneck speed. Experiments similar to those with uranium have been performed on thorium ($^{232}Th_{90}$) with similar results, except that only fast neutrons are effective in splitting the thorium nucleus, while both fast and slow work well on uranium. Other heavy elements, such as gold and tungsten, show some slight tendency to undergo fission.

Fermi and others have been trying to determine which of the three uranium isotopes are involved, and how the process is related to the speed of the neutron projectiles. Duke University scientists are investigating gamma radiations connected with fission, and the University of California is piling up data in all branches of the research. Bohr at Princeton, Solomon in Paris, and many another are concerning themselves chiefly with theory.

Irene Curie and P. Savitch, who were responsible for much of the ground work enabling Hahn to identify the products of his fission experiments, have been carrying on the classification work in Paris. Joliot, as well as groups of physicists at Columbia, the Carnegie Institution, and Cambridge University, have concentrated on the study of secondary neutrons emitted at the moment of fission and in later reactions.

The latter problem brings up an interesting and rather disturbing aspect of the case. These secondary neutrons constitute a fresh supply of "bullets" to produce new fissions. Thus we are faced with a vicious circle, with one explosion setting off another, and energy being continuously and cumulatively released. It is probable that a sufficiently large mass of uranium would be explosive if its atoms once got well started dividing. As a matter of fact, the scientists are pretty nervous over the dangerous forces they are unleashing, and are hurriedly devising means to control them.

It may or may not be significant that, since early spring, no accounts of research on nuclear fission have been heard from Germany — not even from discoverer Hahn. It is not unlikely that the German government, spotting a

potentially powerful weapon of war, has imposed military secrecy on all recent German investigations. A large concentration of isotope 235, subjected to neutron bombardment, might conceivably blow up all London or Paris.

It has been impossible, even in this long article, to mention all the thousand aspects of this fascinating phenomenon, or name many of the able contributors to the sum of information amassed since last January. But the fact remains that nuclear fission is the most important scientific discovery of the year, and holds who knows what promise for the future.

The Uranium Problem by Werner Heisenberg (1942)

Full title: The Theoretical Foundations for Obtaining Energy from Fission of Uranium

{*Manuscript of the lecture delivered February 26, 1942 at the House of German Research*.}

At the beginning of the work on the uranium problem, done in the framework of the Army Weapons Bureau task force, the following experimental facts became known:

1) Normal uranium is a mixture of three isotopes: $^{238}U_{92}$, $^{235}U_{92}$ and $^{234}U_{92}$ which are found in natural minerals approximately in the relationship 1:1/140:1/17,000.
2) The uranium nuclei can, as Hahn and Strassmann discovered, be split by means of neutron irradiation; specifically, the nucleus of $^{235}U_{92}$ by neutrons of all (including low) energies (Bohr), and the nuclei of $^{238}U_{92}$ and $^{234}U_{92}$ only by means of fast neutrons.
3) Each fission releases, per atomic nucleus, an energy of about 150 to 200 million electron volts. This energy is about 100 million times greater, per atom, than the energies released in chemical reactions. Furthermore, in each fission reaction a few neutrons are ejected from the atomic nucleus.

From these facts can be concluded: If one managed, for example, to split all the nuclei of 1 ton of uranium, an enormous energy of about 15 trillion

kilocalories would be released. It had been known for a long time that such high amounts of energy are released in nuclear transmutations. Before the discovery of fission, however, there was no prospect of inducing nuclear reactions in large quantities of material. For in artificially induced reactions in high-voltage facilities, cyclotrons and so on, the expenditure of energy is always much greater than the energy produced.

The fact that in the fission process several neutrons are ejected opens the prospect, on the other hand, that the transformation of large quantities of material could be effected in a chain reaction. The neutrons ejected in fission would, for their part, split other uranium nuclei, more neutrons would be produced, and so on; by repeating this process many times one obtains an ever greater increase in the number of neutrons, which only stops when a large proportion of the substance has been transformed.

Before addressing the question of whether this program can be carried out in practice, it will be necessary to study more closely the various processes that can generate a neutron from uranium. A neutron liberated in fission can either, if it has enough energy, after traveling a short distance, collide with another uranium nucleus, split it and generate another neutron, or it can—and unfortunately this is much more likely—just give up energy in the collision to the nucleus, without splitting it, whereupon the neutron continues on its way with less energy. In this case the energy of the neutron will be so small after a few collisions that only the following possibilities exist for its destiny: In the course of colliding with an atom it can get stuck in the nucleus, in which case further propagation is impossible; or—and this unfortunately is rather

improbable—it can collide with a nucleus of $^{235}U_{92}$ and split it. Then further neutrons are generated in the process, and the events just described can begin again. Some of the neutrons can escape from the surface of the uranium bulk and thereby be lost.

The exact description of the probabilities of each process taking place was an important programmatic point in the work of the task force, and Mr. Bothe will report on the results.

For our purposes it is sufficient to state that in natural uranium, neutron absorption (in which a neutron is captured by $^{238}U_{92}$, yielding the new isotope $^{239}U_{92}$) is much more common than fission or propagation.

Therefore the chain reaction we are looking for cannot take place in natural uranium, and one has to sniff out new ways and means of effecting initiation of the chain reaction.

The behavior of the neutrons in uranium can be compared to the behavior of a population, such that the fission process has an analog in marriage and neutron capture in death. In normal uranium the death toll greatly outweighs the number of births, so that the existing population always will have to die out after a short time.

An improvement in the fundamentals obviously is possible only if one succeeds in (1) raising the number of births per marriage, (2) boosting the number of marriages or (3) reducing the probability of death.

Possibility (1) does not exist in the neutron population, because the number of neutrons per fission is established by natural laws and constants that cannot be influenced. (For the determination of these important constants, take note of the talk by Mr. Bothe.)

There remain therefore only paths (2) and (3). An increase in the number of fissions can be reached if one enriches the uranium in the fissionable but much rarer isotope $^{235}U_{92}$. If in fact one succeeded in producing pure $^{235}U_{92}$, then the conditions would come into play that are portrayed on the right side of the first figure. Every neutron would, after one or more collisions, cause another fission, provided it did not escape from the surface. The probability of death by neutron capture is vanishingly small compared with the probability of propagation. So if one just assembles a certain amount of $^{235}U_{92}$, so that neutron loss through the surface stays small compared with internal multiplication, then the number of neutrons will increase enormously in a very short time and the whole fission energy of 15 trillion kilocalories per ton is released in a fraction of a second. The pure isotope $^{235}U_{92}$ undoubtedly represents, then, an explosive material of unimaginable force. Granted, this explosive is very hard to obtain.

A big part of the work of the Army Weapons Bureau task force has been devoted to the problem of enrichment, that is, the production of pure $^{235}U_{92}$. American research also appears to be oriented in this direction, with considerable emphasis. In the course of this session Mr. Clusius will report on the status of this question, and so I will not have to go into it any further.

There remains to be discussed now only the third possibility for initiating the chain reaction: reduction of the death toll, that is, the probability of neutron capture. According to general principles of nuclear physics it can be assumed that the probability of capture becomes large only at very specific neutron energy levels. (The investigations of the past year have yielded valuable results on just this point.) If one succeeded in quickly slowing the neutrons, without too many collisions, to the region of lowest possible energies (that is, the energy region given by thermal motion), then one could reduce the death toll substantially. In practice one can effect a rapid diminution of neutron speed by adding suitable braking substances, (editor's note: *a moderator*) that is, substances whose nuclei—when hit by a neutron—take away part of the neutron's energy. If one adds enough braking substance, then one can bring the neutrons without danger into the region of lowest energies. But unfortunately most braking substances have the property of also capturing neutrons, so that too much braking substance will increase the probability of capture, that is, the death toll. These relations are portrayed schematically on the other side of the first figure.

It is a question, accordingly, of finding a moderator that quickly removes energy from a neutron without, as far as possible, absorbing it.

The one substance that does not absorb at all, helium, unfortunately cannot be used because of its low density. The most suitable material almost certainly is deuterium, which is available in its simplest combination— and also in sufficient proportion—in water. Admittedly, heavy water is not easy to obtain

in large quantities. The task force has initiated thorough investigations into the production of heavy water and other substances that are possibilities, such as beryllium and carbon.

Pursuant to an idea of Harteck, it has proved advisable to separate the uranium and the moderator, so that the kind of arrangements result that are seen in the layered ball shown in the second and third figures, which was built as a small-scale experiment at the Kaiser-Wilhelm Institute.

Whether this kind of layering of natural uranium and moderator can lead to a chain reaction and therewith to the liberation of large energies, that is, whether the "death rate" can be reduced enough for the "birth rate" to outweigh it, so that an increase in the population begins, has to be regarded as a completely open question, since the properties of the few substances that can be used as moderators are given and cannot be changed.

To illuminate this point was again one of the most important assignments of the task force.

Let us now assume for a moment that this question has been resolved in a positive sense; then it still has to be investigated how this particular arrangement behaves with greater multiplication of the neutron population. It turned out that multiplication does not stop only when a greater part of the uranium is transformed, but much sooner. The ever greater propagation leads in fact to a strong warming, and with the warming— since the neutrons move faster and therefore spend less time in the neighborhood of a uranium

nucleus—the probability of fission gets smaller. The warming has as a consequence, then, a diminution in the number of "marriages" and hence in the multiplication; because of that, at a certain temperature the neutron multiplication will be exactly balanced by absorption.

So the layered arrangement as described will stabilize itself at a certain temperature. As soon as energy is drawn from the machine, cooling and a renewed multiplication set in, and the drawn energy in turn is replaced by fission energies; the machine stays for all practical purposes at the same temperature.

One arrives with this at a machine that is suitable for heating a steam turbine and that can put its very large energies over a period of time at the disposal of such a thermal power machine. One can therefore think of practical applications for such machines in transportation, especially in ships, which would acquire enormous range from the huge energy reserve contained in a relatively small quantity of uranium. That such a machine does not burn any oxygen would be a particular advantage if used in submarines.

As soon as such a machine is in operation, the question of how to obtain explosive material, according to an idea of von Weizsäcker, takes a new turn. In the transmutation of the uranium in the machine, a new substance comes into existence, element 94, which very probably—just like $^{235}U_{92}$ —is an explosive of equally unimaginable force. This substance is much easier to obtain from uranium than $^{235}U_{92}$, however, since it can be separated from uranium by chemical means.

Whether a mixture of uranium and moderator can be found in which the chain reaction can take its course has still—as stated—to be determined by experiment. But also, when such a mixture is found, a large quantity of this mixture must still be amassed to allow the chain reaction really to run, since with smaller quantities the loss of neutrons through the surface always will be greater than the internal multiplication. Experiments with very small quantities of substance are therefore from the outset insufficient for deciding the suitability of the mixtures for the chain reaction. Without generous support of the research work—with materials, radioactive sources, funds—as obtained from the Army Weapons Bureau, it would not have been possible to progress. But even with the larger quantities— for example, of heavy water—that have been made available, the chain reaction still cannot take place. Therefore we must still touch on the question of how one can recognize in a small-scale experiment whether in the chosen mixture the "birth rate" is outweighing the "death rate."

To resolve this question effectively, one introduces into the mixture a neutron source about which it is known how many neutrons per second it emits. If the number of neutrons escaping from the mixture is greater than the number introduced with the source, then one can conclude that multiplication is outweighing absorption and that a suitable mixture has been found.

Experiments conducted in Leipzig in the last few years have shown that a certain mixture of heavy water and uranium actually has the desired properties. To be sure, the surplus of the "birth rate" over the "death rate" was

so small in these experiments that it was canceled by additional absorption in the container material. But the container material can be dispensed with later or can be replaced by something else.

To the extent one can extrapolate from laboratory-scale experiments to large-scale experiments, the experiments unequivocally support the possibility that with a layering of uranium and moderator a machine can be built as indicated. The results to date can be summarized as follows:

1) Obtaining energy from uranium fission is undoubtedly possible if enrichment in the $^{235}U_{92}$ isotope is successful. Production of *pure* $^{235}U_{92}$ would lead to an explosive of unimaginable force.
2) Natural uranium also can be used for energy production in a layered arrangement with heavy water. A layered arrangement of these substances can transfer its great energy reserve over a period of time to a thermal power machine. Such a reactor provides a means of liberating very large, usable quantities of energy from relatively small quantities of substance.

An operational machine can also be used to obtain a hugely powerful explosive; over and above that, it promises a number of other scientifically and technically important applications, which go beyond the scope of this talk.

spaltung means “fission” and *einfang* “capture.”

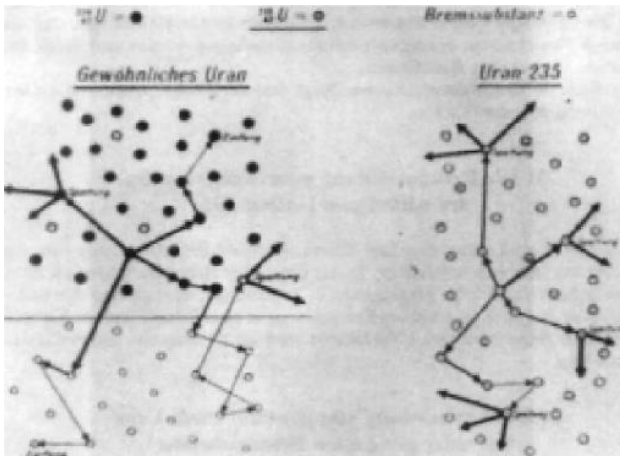


Fig. 1: Normal Uranium with a moderator (left) pure $^{235}U_{92}$ (right)

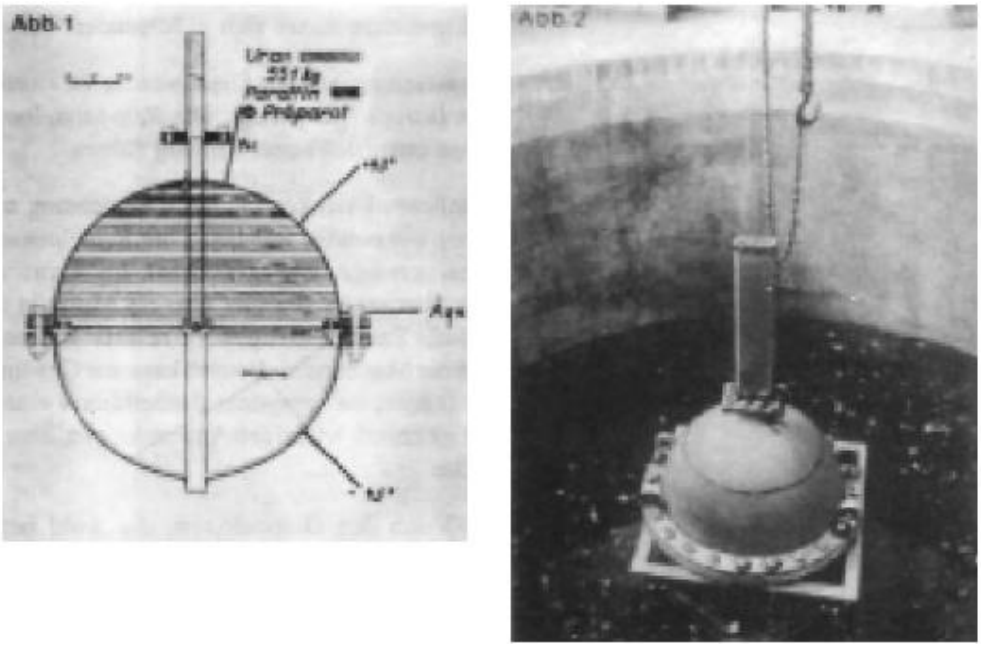


Fig. 2: Schematic of a pile Experiment, with alternating layers of Uranium metal plates (550 kg) and paraffin, enclosed in a stainless steel sphere (left) and in light water pool (right)

Dr. Hideki Yukawa Comes to America (1948 – 1954)

by Patrick Bruskiewich
Director, Vancouver Institute of Advanced Studies

{Disclaimer from the Editor: Patrick Bruskiewich's statements of fact and analysis do not necessarily reflect the official views of any government, past or present, including those of the United States or Japan.}

Dr. I. I. Rabi won the 1944 Nobel Prize in Physics for his work on electron spin resonance.

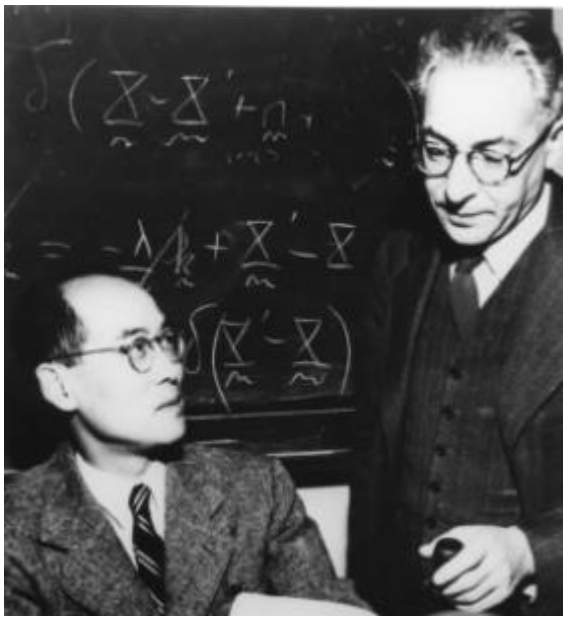


Fig. 1: Dr. I. I. Rabi with Dr. Hideki Yukawa (Columbia, circa 1949)

Dr. Rabi was a well respected physics professor at Columbia University from 1923 (when he did a Master's Thesis with Dr. Albert Willis) to 1988, the year of his passing. Rabi was one of the Godfather's of 20th century American science. [1]

A few years before he died of ocular melanoma, Dr. I.I. Rabi (1898 – 1988) and his wife Helen (née Newmark, 1914 – 2016) paid a week-long visit to the Physics Department of the University of British Columbia, in Vancouver, Canada. As a young undergraduate I was asked by UBC and by one of my professors Dr. Meyer Bloom (1928 -2016) to help host Isidor's visit (I use his first name because Dr. Rabi gave me permission to address him by his first name). Meyer had taught me Quantum Physics and he thought me to be one of the best student he had on the subject over his four decades of teaching at UBC. In the 1960's Meyer established the Nuclear Magnetic Resonance (NMR) lab at the UBC Physics Department. Meyer is also famous for undertaking the transverse Stern-Gerlach Experiment with Dr. Karl Erdman of UBC. [2] [3]

During his 1985 visit to Vancouver Dr. Rabi also toured TRIUMF. TRIUMF is Canada's premier nuclear accelerator laboratory and is located on the south campus of UBC. In an informal conversation with its director Dr. Erich Vogt, Isidor inquired whether a proton beam could be set up to treat his ocular melanoma. While this undertaking would not be forthcoming before his passing in 1988, this informal conversation became the beginnings of the proton therapy program at TRIUMF which was established a decade after Isidor's visit.

After his visit to the Physics Department and to TRIUMF. Dr. Rabi and his wife Helen flew directly to CERN, a lab he helped to establish in Europe. Dr. Rabi invited me to join them on this trip but I had to decline because I did not have a passport at the time. If I had a passport at hand I would have packed a small bag and joined them on their trip. Dr. Rabi was prepared to purchase the ticket and pay for all my trip expenses out of his scholarly grants he received from the American Academy of Science and Columbia University.

As you read this article you may begin to understand the reasons why Isidor extended to me scholarly courtesy. As a Catholic my calling was decided by my Polish grandfather and I in 1978 with the election of a Polish Pope John Paul II. My calling was to help bring a peaceful end to the Cold War. I am also a very capable nuclear physicist (having been taught this subject by many luminary nuclear physicists).

In the 1980's many of the scientists who established the nuclear age and the madness of *Mutual Assured Destruction* were getting on in age and passing away. Some, like Isidor, worried for the future of humanity and turned to young scientists with a conscience to mentor them and help them bring a peaceful end to the Cold War. In subsequent years many professors from Columbia University, including Hans Bethe, and throughout the United States, would accord to me their valuable time and confidence based on a personal recommendation by Dr. I. I. Rabi.

In his last days in 1988, as cancer spread throughout his body, Isidor was reminded of his greatest achievement when his physicians examined him using NMR. To his attending physician he remarked: "*I saw myself in that machine... I never thought my work would come to this*." He died in his bed on January 11th, 1988.

The summer previous to Dr. Rabi's visit to UBC I had worked on an interesting experiment at TRIUMF that involved muon capture within the nucleus. The experiment was a confirmation of calculations that were made by Dr. J. Robert Oppenheimer and Dr. Hideki Yukawa during Dr. Yukawa's year-long stay at the Princeton Institute for Advanced Studies in 1948/49 (Fig. 2: Dr. J.R. Oppenheimer with Dr. Yukawa, PIAS (1949).



Fig. 2: Dr. J.R. Oppenheimer with Dr. Yukawa, PIAS (1949)

It thrilled Dr. Rabi to hear that I was part of a nuclear physics experiment confirming the theoretical efforts of two of his closest friends "Oppie" and Hideki.

In Isidor's Own Word …

In Isidor's own words, expressed to me nearly four decades ago, let me explain the reason why Yukawa was brought to America and why after a year at Princeton Institute for Advanced Studies (PIAS), Yukawa would go to Columbia in 1949.

After the atomic bombing of Hiroshima and Nagasaki, and after the surrender of Japan in September 1945, a cursory investigation of Japanese wartime nuclear research was undertaken by 'scientifically inept bureaucrats' (Isidor's words) of the American occupying authority. This investigation was by no means as extensive as the Alsos Mission to Germany, which itself was incomplete given its lack of access to locations within the Soviet Zone, as well as a lack of honesty by German scientists. [4]

In their mad rush to close the final chapter of history known as the Second World War, the investigators took what was said to them by Japanese scientists like Dr. Yoshio Nishina, at their word. The Japanese had decided not to cooperate with the occupying forces when it came to disclosing their wartime nuclear research.

Due to this lack of cooperation by Dr. Yoshio Nishina and his colleagues the decision was made within the Manhattan District to deprive Dr. Yoshio Nishina and his colleagues of their two cyclotrons. The cyclotrons were dismantled and tossed into Tokyo Bay. The message was clear: Dr. Nishina hoped to be the first Japanese scientist to win a Nobel Prize. Without his cyclotrons he would never make the fundamental discoveries that he hoped to make that would earn him a Nobel Prize.

In the aftermath of defeat, Dr. Nishina and his colleagues had crafted a careful, obfuscating history that, among other things, explained that they had not mastered the chemistry of Uranium Hexafluoride, and did not achieve any degree of enrichment of ^{235}U, in particular using the so called Clusius- Dickel process that the Germany shared with them during the war. As revelations by independent sources like Dr. Paul Kuroda would show, nothing was further from the truth.

In 1947 when rumors began to circulate in Washington of extensive wartime Japanese nuclear research facilities in North Korea, and of contemporary nuclear work being done by the Soviets in North Korea, a second investigation was opened (the final report of this second inquiry still remains classified) into nuclear related activities in Konan (Hungnam) and around North Korea. The newly formed Central Intelligence Agency would also begin their own investigations in 1948.

In 1947 Dr. Nishina and several scientists in the know were asked to 'come clean' about Japanese wartime nuclear research. There were only a handful of Japanese scientist who 'came clean' and one was Dr. Hideki Yukawa.

In Dr. Rabi's own words:

> *"I knew Nishina and neither trusted him, nor his judgment. He was very old school Japanese and crafty. Hideki, on the other hand, was incapable of lying, but sometimes he was quiet. Hideki was a very precise and brilliant thinker. If you needed a specific answer from him, you had to ask a specific question … when asked specific questions in a knowledgeable and scientific fashion … he provided specific and accurate answers in return. Unlike Nishina who was a nationalist, Hideki was an internationalist. "Oppie" and I were both on the AEC at the time. We met and discussed nuclear policy matters quite often. We read the 1947 report about Japanese wartime nuclear work, and knew we needed to get to the bottom of what was going on in North Korea. This is why Yukawa was invited to America … he was willing to tell us the truth … In 1947"Oppie" and I made arrangements to invite Hideki to America, and to do so very publicly. We decided that if Yukawa cooperated with us we would recommend him for a Nobel Prize. and help him become the spiritual leader of post war science in Japan… I looked after the Nobel Prize side of things … It was to be out with the old (Nishina) … and in with the new! … After Yukawa won his Nobel Prize in 1949, we didn't expect things to turn into such a street brawl!"*

I asked Isidor what he meant by 'such a street brawl.' He explained that he had grown up on the rough and tumble streets of New York. The nationalist Nishina and his clique turned the whole matter into a street brawl with the internationalists and Yukawa in particular, and that the battle between the two scientists and their cliques was a microcosm of sorts of Japanese post-war politics: ... cooperate/ don't cooperate; Go it alone/ become part of the United Nations; Get back at the Americans/move on and get on with life … Things changed quickly after North Korea invaded the South in 1950. The old school lost out …

In 1947, around the time that the second investigation was ongoing and rumors began to circulate that Dr. Yukawa would be going to America, in a brazen defiance of the occupying authorities, and to assert his place in the post-war Japanese scientific world, Dr. Nishina asked to be published in the *Bulletin of Atomic Scientists* a memorandum he wrote in 1945 about the cyclotron issue.

Here is the article in its entirety (**SCAP** means Supreme Commander for the Allied Powers – from August 1945 to April 1951, a position held by Five Star General Douglas MacArthur until he was fired by President Truman for insubordination).

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A JAPANESE SCIENTIST DESCRIBES THE DESTRUCTION OF HIS CYCLOTRONS

by Yoshio Nishina

Bulletin of the Atomic Scientists, (1947) 3:6, 145-167

{*The following memorandum was made by Dr. Nishina as a contemporary record of the destruction of the cyclotrons in the Institute of Physical and Chemical Research in Tokyo, of which the author is Director. The account was brought back by Dr. Paul S. Henshaw, a member of the Atomic Bomb Casualty Commission, and is published here for the first time. Dr. Nishina is a well known nuclear physicist who has worked in the United States and in Copenhagen*.}

Under the date of October 15, 1945, request was filed with the SCAP for the permission to operate the cyclotrons in the Nishina Laboratory for the purpose of research in biology, medicine, chemistry and metallurgy. The permit was immediately granted, but it was later restricted to investigations only in the field of biology and medicine. While we were getting ready for work along the lines authorized, suddenly on November 20, the Laboratory was subjected to investigation by SCAP GHQ, and in the evening of November 22, a memorandum was transmitted through the Central Liaison Office, rescinding the previous authorizations and directing that the research be stopped. On November 24, at 8:30 A.M., Major O'Hearn, GHQ, gave us the order for the destruction of the two cyclotrons in the Laboratory, one weighing 220 tons,

and the other 28 tons. The destruction was accomplished in five full days, by Engineers of the 8th Army, working day and night.

In the afternoon of November 24, Nishina went to the Central Liaison Office, reporting the actual condition of the destruction of the cyclotrons, and, accompanied by Mr. Iguchi, Secretariat- General of the Office, presented himself at GHQ, where he met Colonel Rider and Major O'Hearn and inquired as to the reason for the destruction of the cyclotrons. The conversation did not reveal anything beyond that the destruction was by the order from the U. S. Government. Nishina asked specifically whether or not the opinions of American scientists were consulted by the Government concerning the destruction of the cyclotrons. To this question Major O'Hearn answered "Yes, of course," adding that Dr. Compton, who was in Japan recently, is stationed at Washington and his opinion is reflected in the Government action. As will be stated later we found subsequently that this information was incorrect.

CYCLOTRONS CANNOT PRODUCE A BOMB

Even today we absolutely fail to understand the reason for ordering the destruction of the cyclotrons. We surmise that cyclotrons might be considered as indispensable for the study or manufacture of atomic bombs. This, however, we know to be a mere "superstition" of uninformed laymen. A cyclotron may have been an important apparatus in the early studies on the creation of atomic bombs, but now that the atomic bomb has been invented, the manufacture of it no longer needs a cyclotron. It is only necessary to have sufficient uranium to produce any number of atomic bombs without the aid of

a cyclotron, and conversely, however many cyclotrons one may have, no atomic bomb can be manufactured without the uranium material. This fact is clearly revealed by the statements of American scientists engaged in the production of atomic bombs.

Now, it is a unified opinion of geologists and mineralogists that Japan does not produce sufficient uranium for the manufacture of an atomic bomb. Even without SCAP directive forbidding it, therefore, there is no possibility of the manufacture of atomic bombs in Japan. It should also be pointed out that the Japanese industrial power, even at the pre-war level, to say nothing of the conditions today, was altogether inadequate for the production of atomic bombs, even if there were enough uranium in Japan. This is an important point which should not be lost sight of in the consideration of the problem.

Our request to SCAP for the authorization to operate the cyclotrons was for the purpose of researches in biology and medicine, aiming at new discoveries which may greatly improve agriculture, forestry, animal husbandry, fishery and medical therapy. This has been the line of thought apparent even before the war, and we expected from such researches no inconsiderable contributions toward the stabilization of national living and improvement of national health in post-war Japan.

It was indeed for this reason that Dr. Compton, Head of the Scientific Intelligence Survey, GHQ, and other scientists associated with him, recommended to GHQ the authorization of the operation of the cyclotrons, and the authorization granted in the first place. That not only this authorization

would be rescinded but also the cyclotrons would be destroyed without adequate notice was almost beyond the limits of our credulity.

LARGER CYCLOTRON JUST COMPLETED

The cyclotrons in question were constructed through the tireless efforts of a few scores of scientists for a dozen or more years, and at the cost of no small amount of money. The larger cyclotron was just completed last year (1944). By the sad and untimely destruction, it was robbed of any chance to make contributions to science.

According to articles, however, appearing afterwards in *The Stars and Stripes* and *Time* magazine, the group of American scientists concerned in the manufacture of the atomic bomb at Oak Ridge, Tenn., declared the wrecking of the Japanese cyclotrons was "wanton and stupid to the point of constituting a crime against mankind," and was "as disreputable and ill considered as would be the burning of Japanese libraries or the smashing of Japanese printing presses," adding that months of continuous operation by the largest cyclotron the Japanese had would at most produce barely enough atomic bomb material to see, and that "it requires pounds of such material to make one bomb." They concluded that "men who cannot distinguish between the usefulness of a research machine and the military importance of a 16-inch gun have no place in positions of authority." Later, Harvard and Massachusetts Institute of Technology scientists sent letters to Secretary of War Patterson, denouncing the destruction of the Japanese cyclotrons. President Compton of the Massachusetts Institute of Technology urged, in a strongly worded letter

to Secretary of War Patterson, immediate dismissal of the officer who gave the order.

It is quite clear that the destruction of the cyclotron produced a considerable discussion among American scientists, and the information given to us by Major O'Hearn that the order for the destruction was given after consulting the opinions of American scientists must be regarded as untrue. According to what was reported by *The Stars and Stripes* and *Nippon Times* there were exchanges of notes between the U. S. Government and GHQ, making it clear that the cyclotrons were destroyed by an order from the War Department. *Nippon Times* printed a San Francisco broadcast stating that Secretary of War Patterson said that the destruction of the Japanese cyclotrons was a case of a mistake in the War Department.

YOSHIO NISHINA
Institute of Physical and
Chemical Research,
Komagome, Hongo, Tokyo
Dec. 20, 1945

P. S. Secretary of War Patterson later came to Japan and he was reported as having said at a press conference on about January 10, 1946, that he would take the responsibility for the destruction of the cyclotrons in Japan, adding that he did not see the message that was sent out, and that their mistake was that they did not consult with their scientific advisers.

*****

Isidor was the person who first told me about Nishina's 1947 BAS article (which I looked up and read after he told of its existence and importance). The following day he asked me about what I thought of the article. He listened politely as I listed out four or five points that I thought were disingenuous by Nishina. Isidor smiled then told me that the decision to destroy Nishina's cyclotrons were made at the highest levels within the authority of the Manhattan District and was in response to Nishina's disingenuous behavior when asked about Japan's wartime nuclear research. He also said that prior to the January 1946 statement Secretary of War Patterson had '*discussed the matter with "Oppie" and I and with General Groves and decided to 'lob the tennis ball' (Isidor's own words) back at Nishina, by being disingenuous in his own manner by stating "they did not consult with their scientific advisers," when in fact he had*. '

To expand the scope of the second investigation and partly in response to the 1947 Nishina memo in BAS, Isidor and "Oppie" made arrangements to bring Dr. Hideki Yukawa to America and from his arrival in America in September 1948 and during his year-long stay at the Princeton Institute for Advanced Studies. "Oppie" hosted Yukawa's visit to PIAS. There are very few pictures taken of Oppenheimer and Yukawa while he stayed at Princeton for obvious reasons – "Oppie" being the father of the US atomic bomb.

In his own words, Dr. Rabi explained to me that one of the main reasons why Dr Yukawa came to America was so that American scientists could debrief

him regarding the Japanese wartime nuclear weapons program and in particular what went on within the IJN program in Konan (Hungnam) and elsewhere in Korea.

While there are very few pictures from 1949 of Oppenheimer and Yukawa, there are many pictures of Dr. Yukawa with Dr. Albert Einstein, the great show piece scholar at the Princeton Institute for Advanced Studies. One of the most famous is a still picture from a film released by the US Information Service in 1954 [5]

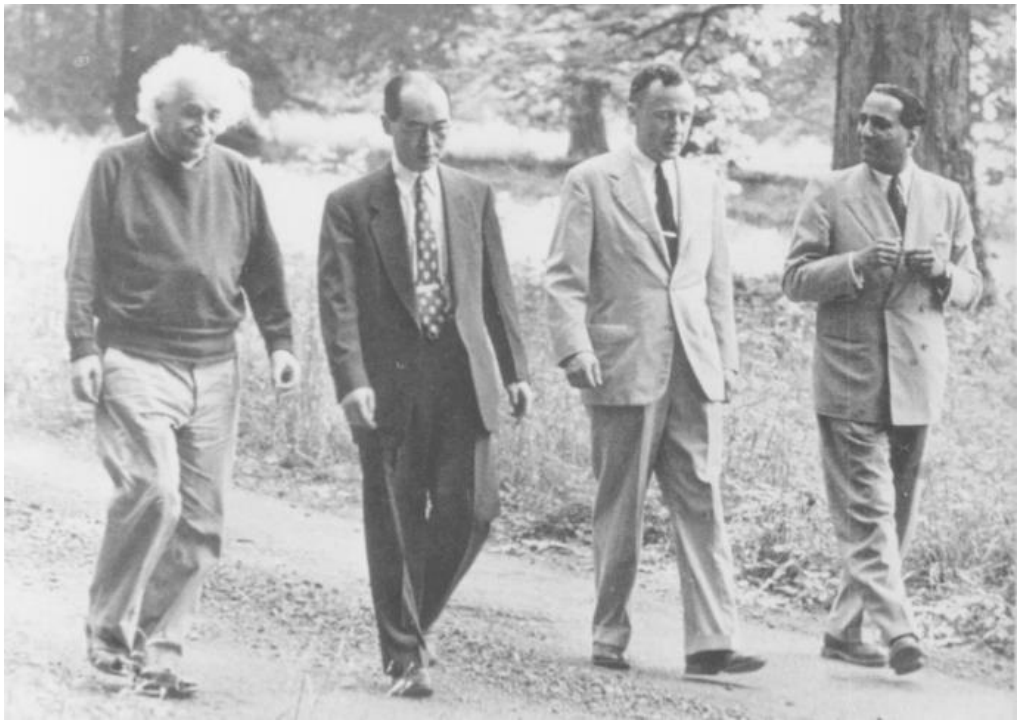


Fig. 3, Einstein, Yukawa, Wheeler and Bhabha

In this picture you have from left to right, physicists Albert Einstein, Hideki Yukawa, John Wheeler, and Homi Bhabha in conversation as they walk

through Marquand Park in Princeton, New Jersey. Historians of nuclear physics will immediately point out that all four men in this picture played active roles in nuclear weapons programs.

Here is where the story of Yukawa's visit to America begins to become interesting.

With regards to Yukawa's visit to the PIAS in 1949, Isidor told me that Dr. Albert Einstein acted as a scientific consultant to the Manhattan District's S-50 Project (Fig. 4: Einstein consulting with the USN Department of Ordnance). [6] Isidor explained to me that the Manhattan District's S-50 Project undertook liquid thermal diffusion enrichment of ^{235}U under the supervision of the US Navy (the so called Clusius- Dickel process). [7]

Isidor stated that both the Japanese and Germans used this process to enrich ^{235}U during the war. The Clusius-Dickel process required copious amounts of superheated steam and is the reason why the US Navy took the lead in this project (US navy ships at the time used superheated steam boilers and turbines).

Almost immediately upon the announcement that he would be spending time in America, Japanese Nationalists had taken offense to Dr. Yukawa's visit to the United States. Dr. Yohio Nishina tried to dissuade Yukawa from traveling to America and tried to persuade him not to discuss the work that was done behind closed doors in the Japanese wartime nuclear weapons program. Dr.

Hideki understood the importance of his visit to America and did not bow under the intense pressure he and his family was put under.



Fig. 4: Einstein consulting with the USN Department of Ordnance

In his own words, Dr. Rabi explained to me that while Dr. Yukawa was in America, the FBI was tasked to provide special protection to him and his family. At PIAS Dr. Yukawa and his family were thought vulnerable. The decision to not extend Yukawa's stay past a year at the PIAS was partly predicated on the larger contingent of FBI agents available in New York City to provide special protection to Dr. Yukawa and his family.

While at the PIAS Dr. Yukawa was debriefed by Albert Einstein and "Oppie" on the liquid thermal diffusion enrichment of ^{235}U undertaken at Konan (Hungnam). Isidor told me that notes were kept of their discussions, but they are not in the public domain.

While at the PIAS and later at Columbia Dr. Yukawa was debriefed by "Oppie" and several other scientists, including Enrico Fermi and Hans Bethe, about the 'devices' the IJN had been working on. [NOTE THE PLURALS] Hans Bethe headed the Theoretical Division of Los Alamos during the Second World War. Given their limited resources Dr. Yukawa and his colleagues had come up with simple and workable designs. Hans Bethe reviewed the designs and declared them workable and even estimated yield (both the designs and yields are not in the public domain.). Perhaps they were gun-type designs for ^{233}U or ^{235}U?

From 1949 to 1954 Dr. Rabi hosted Dr. Yukawa's five year appointment at Columbia University. During this period Five Star General Dwight D. Eisenhower was President of Columbia University from June 1948 until January 19, 1953. On January 20th, 1953 Eisenhower would be sworn in as the 34th President of the United States.

During those five years of Yukawa's visit to Columbia Dr. Rabi was a senior member of the US Government's Atomic Energy Commission. During this same period the AEC undertook began development of the first generation of small yield tactical nuclear weapons (yields of 0.3 to 5 kt) that entered the US nuclear inventory in 1954.

Why then was Yukawa brought to America? You may wonder why the term 'brought' is used instead of invited. From 1945 to 1954 Japan was under the authority of the Occupying Powers (SCAP). When provided an 'invitation' the likes of which was given Dr. Hideki Yukawa in 1948, from Princeton and in particular J. R. Oppenheimer, it was less an invitation that a summons. The summons involved some rather sophisticated diplomacy.

It was understood in 1940's that Dr. Yoshio Nishina (1890-1951) was considered the godfather of modern Japanese Science. In the 1930's Dr. Hideki Yukawa had been one of Nishina's finest students.

During the Second World War Dr. Nishina had been one of the proponents of the Japanese atom bomb project and had work vigorously to bring the Japanese program to the very precipice of a test of a 'device' or design. Much of the work that Dr. Nishina and his colleagues had done is outlined in the 3rd edition of Mr. Robert Wilcox's book *Japan's Secret War* [8].

Dr. Hideki Yukawa was directly involved in the F-Go Japanese atom bomb project established by the Imperial Japanese Navy in 1943. He remained in Kyoto n University while doing this work. Much of their industrial efforts were centered near Konan (now Hungnam) in Korea. Much of the work that was done in Konan remains only partly known to Western observers, but is fully known by North Korea, Chinese and Russian (formerly Soviet) intelligence, counterintelligence and scientific organizations.

In his 2019 book Robert Wilcox argues that the beginnings and foundations of the North Korean nuclear weapons program were set down by the Japanese during the war. There is extensive *prima facie* evidence to support this contention. To add emphasis to his third edition of his book (the first edition was published in 1985) Mr. Wilcox made arrangements to have his revised and updated third edition of *Japan's Secret War* translated into Japanese and sold in Japan.

Trying to determine the facts about Japan's wartime nuclear weapons work when for over seven decades Japanese authority have actively tried to hide or obfuscate facts, is like trying to speculate what is at the center of a Matroyshka doll when all you see is the outside.

In the middle of one of our conversations, Isidor suddenly asked me a nuclear physics question:

"*How do the degrees of freedom relat to critical mass?*"

I thought about this question for perhaps fifteen seconds and said it might be a factor between two and three …

'*go on*' Isidor said.

I said it was perhaps closer to two than three.

'*go on* …' I said perhaps around 2 and a third?

He smiled. "*And how many degrees of freedom can one design into a 'device?*"

I was about to say three when I realized the way he was looking at me that Isidor wanted me to be clever … and so I said **Four**.

The smile on his face said it all. "*And what is the fourth*?" …

The answer slipped out off my tongue before I really thought about it …"To implode and explode at the same time."

He nodded …"and how much material would you need for four degrees?"

I asked him the type of fissile material.

"^{233}U "… I had not thought of using Uranium-233!

I took out my pocket calculator and calculated … between 2.25 and 2.5 Kg.

He nodded again. "And the yield …"

"Several kilotons … perhaps between 5 and 10 kt."

That afternoon Isidor bought me lunch!

The '*fourth degree of freedom*' was one of the gems from the debriefing of Dr. Yukawa. Some of the insights shared by Dr. Yukawa would play a role in US designs of advanced nuclear weapons. Many of the two point detonation, light weight US nuclear weapons are a result of insights shared by Dr. Yukawa with Hans Bethe, and in turn Carson Mark.

A Nuclear Tsunami

Isidor smiled and said he heard that I had served in the Royal Canadian Navy as a naval reserve officer. I nodded. He paused for a moment and then sort of rolled his eyes behind his round glasses and asked me if I could keep a secret? I nodded.

He continued. "One of the reasons why the Imperial Japanese Navy was interested in nuclear weapons was because they knew the US navy would have to approach Japan to invade the Mainland, and it would be the IJN and not just the kamikaze that would have to do battle with the USN as they tried to invade Japan.

In 1945 when the US first debriefed Hideki, it was he who pointed out the best way to sink the attacking ships was to detonate a large blast underwater, causing the ships to crack open, flounder and sink. A nuclear tsunami!

My jaw instinctively dropped and I uttered "Crossroads?" And Isidor nodded, "yes when we did the Crossroads test in 1946, we found Yukawa was right! In 1948 he told us he was working on something special."

I guessed “a nuclear torpedo?”

“Do you know where the Imperial Japanese Navy’s torpedo works were?

I guessed again “Hiroshima?”

Isidor bought me lunch two days in a row …

{This is the first installment of several articles about the conversations I had with Isidor Rabi when I helped to host his visit to the Department of Physics.}

References:

[1] Dr. I. I. Rabi,

[2] Bloom, M.; Erdman, K., *The transverse Stern-Gerlach experiment*, *Canadian Journal of Physics*, (1962), 40(2): 179–193

[3] For six years I shared an office with Dr. Karl Erdman while we commercialized the TR series of nuclear medicine cyclotrons designed by TRIUMF and built in Richmond, BC by a Canadian high-technology company. Our competitors were General Electric and Siemens, two of the world’s largest technology companies. In the 1990’s Karl and I were the godfathers behind the success of this Canadian cyclotron company. Karl passed away in 2014.

[4] Dr. Fred Kaempffer was invited to UBC in 1949 to help expand the West’s understanding of the German wartime nuclear programs, in particular those in the Soviet sphere of influence. One of Dr. Kaempffer’s books would become

a standard college book in the Soviet Union. Dr. Kaempffer will be the subject of articles under a separate cover.

[5] From the film – The Yukawa Story: https://archive.org/details/gov.archives.arc.53506

[6] Refer to: https://www.history.navy.mil/our-collections/photography/numerical-list-of-images/nara-series/80-g/80-G-40000/80-G-42919.html

Description: Albert Einstein in his study at Princeton University, Princeton, New Jersey, where he was engaged in research for the U.S. Navy, 24 July 1943. With him are Captain Geoffrey E. Sage, USN, Commanding Officer, Naval Training Station, Princeton (at left); and Lieutenant Commander Frederick L. Douthit, USNR, Executive Officer, Naval Training Station, Princeton. Official U.S. Navy Photograph, now in the collections of the National Archives.

[7] refer to: https://en.wikipedia.org/wiki/S-50_(Manhattan_Project)#:~:text=The%20S%2D50%20Project%20was,pursued%20by%20the%20Manhattan%20Project.

[8] Wilcox, R.., *Japan's Secret War*, Permuted Press, (2019) New York, Tokyo

Art

An Interview of Michelle

Saturday Dec. 2021
In the Atelier

Patrick: Good morning, Michelle.

Michelle: Hi.

Patrick: How are you today?

Michelle: I'm pretty good,

Patrick: Marvelous. So, we're doing an interview for Art and Eros magazine about your art and your artistry and your philosophy as an artist. And what you see in your future as an artist. The first thing I'd like to ask you is your philosophy about your pastels. How you enjoy doing art with pastels, and what it is you enjoy most about pastel art, maybe two or three things about pastels?

Michelle: Well, I love that there is such a variety of color. There is something so satisfying about being able to blend the colors together. It feels like I'm

really doing art. And every piece of artwork that I do, I have put my fingerprint on it, and touches it. This is a part of my expression.

Patrick: You enjoy the chalk pastels, not the oil pastels, is that because of the texture.

Michelle: I like both. I don't have any preference.

Patrick: And you had showed me a remarkable box of pastels that you've been doing art with pastels, since you were very, very young. I believe it was when you were six years old. Tell me about that box of pastels. Tell me about what it means to you today. As you open it up, and you use the colors from the past.

Michelle: Oh, *Hahaha*. There's not a lot left because it's pretty used, but it was actually I think my older cousin. And then she had it handed to my sister and my sister handed it down to me. And it's really beautiful how something as simple as just a box of pastel could be enjoyed by so many people and all of us did different things with it.

Patrick: And tell me about some of the works of art you've done with this very special box of pastels. What are some of the things or art pieces you have done with them going back to the earliest time that you can remember?

Michelle: One in particular that I'm remembering was, I drew an underwater scene. And there were like, fish, and seaweed and sand, using colors like the blues and the greens and brown, yellow, yellowy brown. And that was really fun.

Patrick: Do you remember how old you were when you did that piece?

Michelle: Well, I would have just moved to Canada. When I was perhaps eleven.

Patrick: Today, when you do pastels, what do you like to do, what are the things that inspire you when you work with your pastels? And a few minutes. And I will ask you about the other forms of art you do. But I thought it would be nice to ask you about your past.

Michelle: Oh, I kind of draw whatever's on my mind. But I really like to draw different types of flower. There's something so satisfying to see the petals falling and opens up and opening up to the world.

Patrick: Your flowers are superb.

Michelle: thank you.

Patrick: Your flowers are really remarkable. I can see the texturing that you do on the petals. And you did recently a sunflower motif with a picture which will be in the magazine and I thought that was just marvelous. And then you did one of me sitting amongst flowers here. And when I saw that my heart just skipped about five beats, it's so beautiful. It's now framed here and it will hang in the Atelier. But I can see, your choice of colors also is refined as well. It's not just representational, but it has an emotional side to things. Tell me about your color theory.

Michelle: Well, I think I first just start thinking about what is the feeling that I want to express and I used [the theme of] color to express those feelings. Sometimes it would be just whatever the flower color would normally be. Sometime, it's more about the vision I wanted to creates and making that contrast and different appearance. So, for example, in the drawing with you and the chameleon, and the carnation I used more kind of reddish skin tone color primarily with some leaves that are green. And I think you kind of blend well within the flowers.

Patrick: Soft … nice … This work of art belongs to the gallery, it is so wonderful. And when I saw it, like I said, my heart skipped five beats, which in this case was a good thing. It's a beautiful work of art. And I can see your emotional center to the art that you do. You've done some portraiture, you

done some flowers. In the last [while], you've done some figuratives, you do love bright colors, I can see if it is that a reflection of your inner spirituality or in your character, bright colors?

Michelle: I think I just like having some cheery things around my life. I think… you know… having a piece of art; art that's dark; kind of brings the viewer down. And I think art is meant to be display. And if I'm displaying [it, then] I want the person to feel happy when they see it.

Patrick: So your philosophy as an artist includes the important notion that art should be uplifting.

Michelle: Yes … I think so. But I also find arts is more about how it helps me with how I feel. When I use bright colors. It kind of reminds me to be bright, colorful, cheerful.

Patrick: Oh, that's marvelous. Tell me about some other art you'd like to do. What are do you like to do? Like photography? Do you like sketching? Do you like painting Do you like sculpture?

Michelle: I really like doing painting, especially landscape. Lately, I've been trying to learn more portrait and figurative drawing with pencil and graphite and other interesting medium. I also really like woodworking.

Patrick: You do silver as well. You do jewelry, don't you as well?

Michelle: Yeah, yeah.

Patrick: So you started doing pastels when you were very young. When did you start to do some of these other forms of art? Was it in school or was it what inspired you for instance to do the silver jewelry?

Michelle: Okay, well, um, what inspired me to do silver jewelry was actually a pretty simple reason; because I want to have a silver ring but my fingers are really narrow and I couldn't buy any. So I'm like, "I want to make my own." That's kind of how it started.

Patrick: Yeah, that's a marvelous reason. Some marvelous reason. And the woodworking, you like to build things right? Like carpentry and things like that.

Michelle: I think it's satisfying to surround yourself with things that you, you know, put your heart and soul into it. It's going to work for you. I've nothing against mass produced things, but there's just something really fun about

having things that you made in your house and you know exactly how you've made it. And if it breaks, you know how to fix it, because you created it.

Patrick: So this is an artistic philosopher. You are, to some extent an artisan. You like to make your own things and you'd like to be artistic while you're doing.

Michelle: Yes.

Patrick: I thought it was rather cute that you have a small car and one of the things you struggle with is trying to put some of your carpentry things into your small car.

Michelle: Yeah, there's always never enough room in my little car ...

Patrick: Oh my, oh my! You are a very spiritual person do you see some of your spiritualism in the art that you do. It's uplifting but do you see something beyond the uplifting? Do you see some particular meaning I know you have done portraitures recently of someone who's significant in your life, and there's a memory of her …

Michelle: I think being a follower of Christ, I recognize that my artistic ability is a gift that God gave me and is a gift that I like to share with the world. I don't think my art have any particular religious association. But I do think that I am left with this gift and I'm grateful for it.

Patrick: Well, one of the things I noticed early on is the fact that it is uplifting your art. There's no darkness to it. It's light. It's happy. It's joyful. It's colorful. And I admire that.

So we talked about the fact that you have a favorite artist, Gustav Klimt. You have actually had a chance to go and visit Vienna and see his artwork in person. Yeah. So, share with us a bit of what you think about Klimt and what you think about his art and how it has affected you and inspired you …

Michelle: Okay. Well, one thing I really liked about Klimt's art is that he's not afraid to paint over something that people will see as very valuable, like he paint over gold and it's very brave of him to do that. And he put efforts into every painting that he did, and that he has this very ingenious counterculture way of approaching art and it is very different and very much of reflection of this character. I think I also appreciate that he's not going to confine to what people think are the norms of the time. I also find that the fact that he portrays women in such a majestic way, it's really refreshing

Patrick: You have a favorite Klimt painting and a frieze …

Michelle: I really like the Beethoven frieze, but I think I also really like The Kiss. I think both pieces of art it has capture something so different. The Beethoven frieze is capturing all the emotional rise and fall of the music. And when you look at it, you could almost hear it in your head, or at least in my head.

And then when I look at The Kiss, I really like how he portrayed the tenderness and the love between the two subjects. And I thought that the clothes, looking down in the gold and the pattern is showing how important and royal love is … something that should be honored and is precious.

Patrick: Oh, my heart is aflutter. What do you see in the future? Do you have plans? Like for instance, in the next few months, the next few years? About your art what you do plan to explore certain themes do you plan to evolve some of your artistic ideas? What do you see in the future?

Michelle: Well, currently, I'm working on a piece of sculpture. And that's going to take me the next couple of months. But what about my artistic vision for the future? I think. I mean, I hope I will continue to do art that are uplifting and bright and colorful. Oh, and I think because everyone's art is a reflection of what they're thinking inside. And I can only hope that both my art and my life, will be uplifting and I live a colorful life.

Patrick: Oh, Michelle, you have a very warm heart, very uplifting character. And I can see that in your art. And I can see that in your philosophy. Is there any advice you would give someone who's starting out in art?

Michelle: Don't be afraid to just grab a pencil and paper and start drawing! Even if you think you're a horrible artist. Just start drawing and you're going to get better.

Patrick: Well, thank you very much for sitting for this interview. I admire your artistry, the softness of your pastels, the theme and also the presentation in the colors I think are most superb. Your colors remind me of the French Impressionists sense of color, where the color defines not just the balance of things but also defines the focus, the presence, the meaning of things. I think that your sense of proportion is marvelous. Your sense of balance is marvelous. Your sense of colors marvelous. Your sense of foreground and background is marvelous. And your sense of the main figure in your art, I think is so superior. It shows to me sophistication in your appreciation, and practices and artists. Thank you Michelle.

Michelle: Thank you

Art Work by Michelle













Reflections on Art School by Olivia Tasaka

[**Montreal**] I was never somebody who knew what they wanted to do with their future. The question always terrified me, and I could never wrap my head around the fact that every adult in my life seemed to believe that by sixteen, I could feel anything close to excitement, much less certainty, when considering my career options. I've changed my mind dozens of times since high school, I've applied, accepted, denied, re-applied, re-accepted, denied… and two years after graduating, I found myself still at home, still not in school, and with no real sense of where I wanted to be. I was watching my childhood best friends approaching the end of their degree, working real adult jobs in the real adult world while I remained at the same cafe I'd been working at for three years, feeling just as directionless as I did when we all graduated high school together. I knew I couldn't continue like this, that the idleness and monotony that defined the last two years of my life was starting to tear away at my psyche. Most of all, I knew that art was what got me through it all: the months of isolation, the growing pains of having to make my own big, defining life decisions, and the sobering realization as we collectively lived through a pandemic that people don't seem to care about each other as much as I once thought they did.

It took me a while to seriously consider art school, despite the fact that I was painting almost every day and that art had been a central part of my life for as long as I could recall. I had been trying to force myself into a more conventional academic pathway, one that I felt was easier to explain to strangers and would warrant less remarks about how I'm not going to survive

in the real world. Yet it became clear to me after years of trying to mold myself into what I thought others wanted me to be that I am not capable of pursuing anything that I truly don't care for.



Within the span of a couple days, I decided to throw together a portfolio and applied to a painting and drawing program in Montreal. I had felt a calling towards this city for a while, as well as a desperate urge to leave Vancouver and experience something different, something other than the same roads and people and places that I had seen everyday for the last ten years. I finally felt ready to go to university, and more than anything I wanted to experience something other than my parents' basement and my high school coffee shop job. A couple months after applying, I was accepted, and in late August I found myself on a flight to Montreal, finally turning the page onto a new chapter in life, full of uncertainty, curiosity, dread, and excitement.

I struggled to really wrap my head around art school at first. This wasn't helped by the fact that despite moving halfway across the country to attend university, I took all of my classes alone in my apartment, painting a canvas while my professor prattled on, confined to a little rectangle on my computer screen. This wasn't the hands-on, in-person experience that I was promised, and it left me feeling a bit jaded. The subjectivity of our grading, the vague, open-ended nature of our assignments, the flexible deadlines…



it all started to feel more like summer camp than school, a summer camp that I completed entirely by myself, never once stepping foot into the school's visual arts building. I wasn't learning colour theory, or how to make an underpainting, or any of the technical skills that I was expecting to be

introduced to; rather, our assignments were almost entirely conceptual, as if I could submit almost anything and it would still be acceptable. I felt as though I wasn't progressing or moving forward in my art, nor in my life; I was stagnating, as I had been for two years, and moving halfway across the country to escape it simply forced me to face the fact that even a completely new environment could not fix me, not if I remained the exact same.

For a couple of months, I allowed myself to wallow in bitterness and succumbed to the misery of my expectations not being met. Perhaps I was to blame for my naive idealism about the future, about turning the page and advancing to a new chapter in life, somehow emerging as a different, changed, and better person afterwards. Perhaps my expectations were too high, and after all, how much of my experience was determined by my own apathy? Looking back on it now, I have to ask myself if my lack of interest in school was my own fault and not a symptom of circumstance. It's certainly easier to blame outside forces than it is to admit to yourself that you simply don't have the drive that you used to.

Embarking on my flight home back to Vancouver for winter break, I felt disappointed in myself for not becoming the person I hoped I would become, for not even really trying to. For allowing myself to coast through my first semester of university, completing everything that needed to be completed but without the passion or intent that I once had. I was painting for the sake of making a deadline, not for the sake of improving my practice as a painter. Nonetheless, a part of me wasn't ready to give up yet, and I knew that one semester of remote learning was only a brief introduction to what the next four

years of my life could look like. Back in my childhood home, surrounded by familiarity and no longer distracted enough to avoid introspection, I was forced to



take a more objective look at what my experience in university had taught me thus far. Two years of social isolation and avoiding academic spaces like the plague had sent me down a path of general apathy towards my future and everyone else's, yet I began to recognize that this hopeless nihilism had become rather damaging to my mental health and motivation. Besides, allowing my disappointment to fester and grow inside of me wasn't getting

me anywhere. I had to accept the fact that in order for me to appreciate art school, something had to change, and that change had to happen internally.



In late January, I found myself back in Montreal, still enrolled full time in art school, and slowly began to discover a lot more value in the courses that I once found obsolete. I was improving noticeably throughout each assignment, and recognizing developments within my own stylistic choices and technical skill level. The content of my courses didn't change much; rather, I started making a conscious effort to examine my progress over the last few months, to ask plenty of questions and to take my assignments seriously, not because

I wanted a good grade but because I wanted to expand and improve upon my art practice. I've realized in the last few months that art school is less about learning colour theory or how to shade a sphere and much more about grappling with your own intrinsic motivation, pushing the boundaries of what you consider your art style, and recognizing the true value and meaning that your art practice has in your life.

There would be nothing without art; I would be nothing without art. I recognize that now more than I ever did before, and in going to art school I reaffirmed this passion of mine and more importantly, forced myself to uncover the ambition within me that I wasn't sure I still had.

Other Works by Olivia







She's Lost Her Head by Sarah Haxby



[**Vancouver**] It's only bad guys that would decapitate a helpless damsel – right? No one would ever suspect that John Everret Millais (1829-1896), an artist well known for his association with the Pre-Raphaelite Brotherhood, and for his hundreds of paintings portraying romantic and allegorical imagery would so such a thing?

And yet Millais literally cut out and removed the original head from the damsel in distress in the oil painting *The Knight Errant* (1870). The damsel in *The Knight Errant* is the only surviving, completed nude by Millais that we know of; it is not known how many other nudes he may have painted over.

The fact that the image does not contain the damsel's original face is not widely known. There was an issue with the original face, but Millais didn't just paint over it, as was the common practice of the time;

instead he carefully cut the original head from the painting, sewed in fresh canvas and then meticulously sewed the first face into a different canvas.


John Everett Millais-1854[2]

The Knight Errant, an image that is still reproduced prolifically today, is an archetypal portrayal of the ideal of chivalry in which a knight rescues a damsel in distress.

The image portrays a knight errant cutting the ropes binding a naked damsel to a large tree. It is twilight, and probably fall or winter as a crescent moon can be seen hanging low in the sky through the leafless branches of the trees. An article of the damsel's clothing lies on the ground. The damsel looks away from the audience and from her rescuer. The knight looks upwards, and appears sympathetically resolute as he performs his noble deed.



The Knight Errant J.E. Milllais, 72 ½"x 53 ¼", oil on canvas, 1870

A knight errant was a roving knight from medieval chivalric romance literature who typically wandered the land in search of adventures to prove himself and to earn glory for its own sake, rather than for monetary reward. The reason behind the creation of the chivalric knight errant has socio-political history that has washed away over time even as the stereotypical character has endured.

One task popular with these knights was rescuing damsels in distress. The traditional damsel in distress is a classic theme in world literature, art, and

film of a maiden – usually a beautiful young woman – placed in a dire predicament by a villain or villains who have either abducted her and taken her to a tower or a cave, or the villains have left her somewhere in a perilous, vulnerable state, usually naked and about to confront a monster as a sacrificial offering, or just abandoned and naked chained or tethered to a rock or tree. The helplessness of the damsel in distress has made the stereotype the target of mockery and feminist criticism. The damsel in distress archetype was created partly to give the knight errant an honourable task to perform, and became popular partially as another way for artists to portray the naked female form without (too much) criticism.

So, what was wrong with the first depiction of Millais' damsel? Why did he have to remove her head and repaint the damsel's face in *The Knight Errant*? According to Millais' son, J.G. Millais, it was "because the work did not sell, the artist later thought the woman would appeal more if turning away from the knight."

It appears John Everett Millais was correct, for after he repainted the damsel the painting sold, and continues to sell and sell and sell.

But who was the original damsel? Was Millais in love with her, or just drawn to her beauty? In the original painting the damsel's face was tilted towards her rescuer, her eyes visible, not looking directly at the audience, but perhaps gazing towards her rescuer. We can understand that Millais changed the composition in order to accomplish the sale of the work, but why did he love the face of the damsel so much that he cut it out and re-used it in another

image, in which he attempted a second nude painting? Millais did not paint nudes, and the woman in *The Knight Errant* is the only known Millais female nude.

The reason for his re-use of the damsel's face is a matter of speculation. Even though Millais kept meticulous notes about his paintings he did not record the name of woman who posed for him. It is known she was real. Millais' records state that live models were used to create the painting. The damsel and the knight in the image were both painted from live models. The background was painted at Wortley Chase:

> "Millais originally painted the distressed lady, who had been robbed, stripped, and bound by thieves, as looking at the spectator, and I remember well this position of the head in the picture as it hung in the drawing-room walls at Cromwell Place; but after a while he came to the conclusion that the beautiful creature would look more modest if her head were turned away, so he took the canvas down and repainted it as we see it now." (J.G. Millais)

The original *The Knight Errant* was described as shocking to the 'Pharisaic spirit of the Age' and so no one dared to purchase the image until after its alteration. Millais' son states that a dealer purchased *The Knight Errant* after its alteration and then after that, in 1874, Mr. Tate purchased the painting to give it to the Nation. Thereafter the painting, which was formerly considered un-saleable, "at once gained the favour of the public."

Even if Millais liked the original face he painted enough to place it in a new canvas, he must have felt that the image of the nude damsel with the strong gaze to the right could not sell in that second painting either. Millais changed her. He repainted her eyes so that they were lowered, and then he added clothes (although there are hints of her naked bosom beneath the sheer fabric in spots, as though he didn't want to completely cover her nudity), and the biggest change was to turn her from being a damsel into that of a martyr.



The Martyr of Solway Firth, J.E. Milllais, 27 ¾"x22 ¼", oil, 1870-1872

Millais created a new composition for the young woman with her hands pulled behind her back: the composition now depicted her chained to a rock. She was turned into *The Martyr of the Solway Firth* (c.1870-1872).

There must be some irony to be found in the fact that this poor damsel in distress was taken from her original situation of being rescued from being tied by a rope to a tree to that of being chained to a rock with no hope of rescue; for the story of *The Martyr of Solway Firth* is a story that does not have a happy ending.

Solway Firth is a large and relatively unspoilt estuary situated on the border between England and Scotland on the West coast of Great Britain. As a young Scottish Covenanter, age approximately eighteen years old, Margaret Wilson was executed by drowning for refusing to swear an oath declaring the King of England as head of the church. She was bound to the rocks of the Solway estuary and drowned when the tide rose.

> "It is said that as the tide rose she defiantly quoted and sang from Scripture, and witnesses described how her hair floated around her head like a halo in the clear water." (anonymous)

Margaret Wilson died on May 11, in either 1684 or 1685. She died alongside her friend, Margaret McLaughlan. McLaughlan, the spelling of whose surname is the subject of debate, did not make it into the stories nor the painting, presumably because she was not young, pretty or virginal enough to be considered a damsel in distress by Victorian standards. Margaret McLaughlan was described as "older," and was not declared a martyr. The two Margarets are thought to be buried in the same churchyard in Wigton. Margaret Wilson became known as *The Martyr of Solway Firth*.

The Martyr of Solway Firth, was the subject of an illustration by Millais for the magazine *Once A Week* in 1862. The subject was one he revisited when he painted *The Martyr of Solway Firth* in 1871, both images created almost two centuries after the historic events occurred.



The Martyr of Solway Firth, X-rayed by Liverpool museum

The painting of *The Martyr of Solway Firth* shows a young woman wearing a lightly patterned, unbuttoned, feminine blouse that is rather translucent in certain areas. We know the painting began as a nude because recently conservators at the Liverpool Museum, which now owns the painting, x-rayed the piece and found that the damsel in distress had originally been the nude originally found in *The Knight Errant*.

I speculate that once again Millais had been stumped by his damsel in distress. He wanted to portray this particular young woman nude, yet found, once again, he could not; and so he once again altered the damsel in distress to make a sale by adding the clothing and the title to provide an acceptable context to the image as afterthoughts rather than painting the picture as a direct inspiration from the story.

Was the decapitation from the original painting necessary? In order to visualize what the original Knight Errant's damsel in distress might have looked like, I've replaced the original head back into the image.

Where are the villains in *The Martyr of Solway Firth*? It is hard to see the villains that surround the damsel in distress as they're usually left out of the picture frame, literally and metaphorically. The villains in the stories associated with damsels in distress are often not portrayed as the focus is usually on depicting the nude female in her state of vulnerable, sexually available distress. In the strange case of *The Knight Errant*, we are not even sure who the story villains were.

The Knight Errant is unusual from Millais' oeuvre as it is an image that does not direct the viewer to a specific narrative, myth or story that the picture is illustrating. Millais' son describes her as a damsel who had been robbed, stripped, and bound by thieves, but what specific story or poem or song this image derives from has been lost.



The Knight Errant with a reconstruction of the original face

It is sometimes hypothesized that the work draws upon the mythology of Andromeda, but as the image lacks any apparent visual tie-in to the story of Andromeda (who was tied to a sea-side rock and rescued by Perseus), I feel that it is erroneous to ascribe the Andromeda story to *The Knight Errant*. As all of Millais' other mythological images draw upon clear sources, I think there likely is a specific story behind The Knight Errant that is being depicted, but the narrative connection has been lost to us.

As with many of the depictions of the damsel in distress, the true villain is not in the picture. The finger of blame as to who the greatest villains are can be pointed in many directions including at the mythic monsters, the absent

villains who stripped the young women and then tied or chained up the damsels, the religious zealots and those who chained up the sacrifices, the kidnappers and dragons who carried the damsels away, the artists who painted the images, the patrons who purchase the images and perpetuated the market for more damsel imagery to be produced, and of course, the audiences who have eagerly flocked, for centuries and who, even in modern times, continue to look time and time again upon the damsels in distress.

The fascination of the damsel in distress continues to fascinate and enslave our attention. Of course, as in the case of Millais' decapitated damsel, we prefer that she looks the other way, the better for us to view her without her looking back at us. In the viewing of such works I am unapologetic of the guilty pleasure that occurs, even in academic consideration of these works, even if it might make villains out of us all.

Falling in Love with a Beast by Emily Mathews

[**Vancouver**] Why does Beauty fall in love with the Beast? Why does the well bred, well mannered lady fall in love with the mysterious and social outcast? He is the object of fear within the community and yet Beauty still falls in love with his beastly form. This inexplicable idea has taken allegorical form, evolved into myth, and has become a common motif that we see in modern fairy tales and storytelling today.

The evolution of the Beauty and the Beast motif results in a development of the original archetypical characters. In C. S. Lewis's novel *Till We Have Faces* he develops the concept that in myth human sympathy is at a minimum. All the characters are like shapes moving in another world. Meyer,in his discussion of *Till We Have Faces,* argues that even though Lewis titles the novel as a retelling of the myth, it is in fact not. Lewis' own characterization of myth works against it "since the psychology of the characters is a major interest." (Meyer 184). Likewise, in modern retellings of Beauty and the Beast, the mythic tale has changed to adopt to the fairy tale genre. It is no longer myth but a fairy tale. Despite the fundamental differences however, the fairy tale could not exist without the original mythic elements.

The Development of the Myth: The Tale of Cupid and Psyche

The predominant, earliest written example of the Beauty and the Beast tale is Apuleius' allegorical Metamorphoses (Accardo 53). The tale is of a beautiful mortal girl, whose beauty is so exulted that the goddess Venus becomes

jealous. As punishment Psyche is sent to marry a monstrous beast "[not] sprung from a bloodline is humans – Only a fell, snake-like beast, wild, sadistic, and cruel." (trans. Relihan 10). Psyche bravely faces her fate but upon seeing her beauty Cupid (who was to escort her to her doom) defies her mother's wishes and decides to take and marry her herself.



Cupid and Psyche by Hugh Douglas Hamilton (1792)

By day Psyche is served by invisible servants and by night her husband, who remains faceless and nameless, enters her bed chambers. One day, after begging to see her sisters, they jealously convince Psyche to look upon the face of her husband, despite his admonitions not to. Psyche does so and as she is looking upon the face his inhumanly handsome face, oil from her lamp

splashes onto his shoulder and wakes him. Cupid leaves Psyche and in despair she attempts to drown herself in a river, but the river will not allow her. Venus finds out about Psyche and attempts to kill her by setting three impossible tasks. If she succeeds then she will be with Cupid again. With help she is successful in all except the final task. Upon returning from the underworld with Persephone's beauty in a box, Psyche's curiosity gets the better of her and she opens it despite specific instructions not to. She falls unconscious and it is only through Cupid's pleas to Juno (Zeus) that Psyche is brought back to life and is made immortal (sum. Relihan).

It has been suggested by Captain Sir Richard Francis Burton that Apuleius got his ideas from early Hindu stories, however there is little to no evidence of that (Accardo 53). However, if this was true it would support the idea that certain basic archetypes appear repeatedly within certain motifs. These characters encompass basic archetypes that are the basis for later fairy tale characters. In the following passage Pasquale Accardo suggests that:

> "What is just as often ignored is the extent to which the themes that recur throughout Apuleius' novel prefigure almost all the major fairy-tale themes: the simpleton who succeeds, the youngest child who surpasses the older siblings, the evil witch/stepmother (Venus), the king elves, helpful animals, insects and birds, cannibalistic ogre (Cupid, the dragon/serpent), terrifying beasts, the clumsy, stupid giant (Lucius as an ass), tales that provide unending feasts, invisibility, captivating music, magical transformations, shrews that need to be tamed, seven-league boots (rapid travel), and enchanted swords and clubs to vanquish

> any opposing powers. The literary Apuleius might be considered the father of the entire fairy-tale genre." (Accardo 48).

Thus, Accardo *argues* that the basic characteristics of Cupid and Psyche transcends generations, appearing in ever popular tales such as Beauty and the Beast, East of the Sun and West of the Moon and King Kong. Psyche's royal family can be applied perfectly within the modern world, and isn't that the defining element of the archetype? You'll never see the embodiment of an archetype, but you will see the recurring symbol of one. Jung used the terms "motifs" and "primordial images" to stand for "archetypes," saying that "the archetype is a tendency to form such a representations of a motif – representations that can vary a great deal in detail without losing their basic pattern. There are, for instance, many representations of the motif of the hostile brethren, but the motif remains the same." (qtd. Snider 4,5).

The role of the wicked stepmother that has become the staple in fairy tales makes her first appearance in *Metamorphoses* in the form of Venus. She enlists her son Cupid to destroy Psyche, her rival in beauty. Venus' antagonism towards Psyche incites Cupid's clandestine marriage to Psyche, resulting in Venus' jealously of Psyche. His mother then turns him into an unseen presence that impels Psyche to believe that her husband is a monstrous beast. The idea is encouraged by her jealous sisters who envy Psyche's God-husband and beautiful palace. These archetypal characters are manifested repeatedly until the wicked step-mother and sisters become the typical fairy tale antagonists.

Looking at Stith Thompson's book on studying folktales, he examines Wilhelm Grimm's explorations into how these resemblances and identical plots can be explained within myth and fairy tales.

> "[Myth's] significance has long been lost, but it is still felt and imparts values to the story, while satisfying the natural pleasure in the wonderful … as gentler and more human manners develop themselves and the sensuous richness of fiction increases, the mythical element retires into the background and begins to shroud itself in the mists of distance, which weaken the distinctness of the outlines but enhance the charms of the fiction." (qtd. Thompson 370)

This suggests that all folktales are broken down myths. Thompson later goes on to create a classification index that lists all the various 'types' of folktales and myths, thus allowing for "recognition of these resemblances … [that] brings scholar[s] closer to an understanding of human culture." (Thompson 6). The tale of Beauty and the Beast is a 'type' of myth that recurs. It suggests that there is a common theme of taming 'bestial' love of 'savage' love throughout many cultures.

Beyond the Archetypes: Till We Have Faces

C. S. Lewis' novel *Till We Have Faces* does not aim to create a fairy tale. Rather in his novel we see Lewis fleshing out and developing the original myth from the point of view of Psyche's sister. Lewis states that "nothing was further from my aim than to recapture the peculiar quality of the

Metamorphoses – that strange compound of picaresque novel, horror, comic, mystagogue's [sic] tract, pornography, and stylistic experiment." (Lewis 313) Lewis' narrative differs from myth in that the psychology of the characters plays a major role. For example, the royal family in Lewis' version would fit perfectly in the modern day: "Redival, the rebellious, slightly slutty daughter; Psyche, the saintly one; Orual, the misfit; and Trom, the abusive father." (Meyers 184). In addition, myths always deal with the fantastical. Lewis changes these unexplainable occurrences so that they inhabit dreams and visions.



Cupid Finding Psyche by Sir Edward- Burne Jones (1866)

C. S. Lewis' novel *Till We Have Faces* is the same myth but retold from the point of view of one of the sisters. What makes it different from Apuleius'

version is instead of a fairy tale-like setting, *Till We Have Faces* is specifically set in a country called Glome that are ruled by kings who have names and faces. This brings a sense of realism; the reader is under the illusion that the narrator is in real place and time bringing us into a literary world.

The most important deviation from Apuleius's version is that Lewis makes Psyche's palace invisible to her sister's eyes. Orual cannot see it because at first it "seems that Orual is too hard-headed, too much of a realist, too scientifically objective, to enter into Psyche's fantasy." Orual chooses what "data [she] will pay attention to, and which she will ignore." (Myers 64) In the myth there is the assumption that fantastical things are everyday commonplace occurrences. Lewis' character Orual denies these magical reasoning and explanations. Her vehement refusal of Psyche's offer to get her husband to enable Orual to see the invisible castle: "I don't want it. I hate it. Hate it, hate it" is evidence of her closed mind (Lewis 124). This is quite unlike myths where magical explanations are accepted and are seen as rational.

Apuleius reveals a myth that enlightens us with stories that bear no realism and are told from an omniscient point of view. This distances the audience from the characters. In contrast, Lewis tells us his tale from a first person narrative. From Apuleius' omniscient point of view the reader is able to observe everything within the worlds of the Gods and the mortals. The reader is present in every scene and we are able to follow Psyche through her trials and tribulations. We are privy to thoughts and deeds, and the political, self-centered squabbling that the Gods take part in. In *Till We Have Faces* the

reader is exposed to only a biased perspective, limited to only what Orual knows. The private lives of the Gods remain just that, private. We don't get an insider look into the marriage of Psyche and Cupid, only glimpses. This allows us for a more realistic viewpoint and "certainly more modern, for twentieth-century authors play on our awareness that knowledge is partial and witnesses often unreliable." (Myers 150) We are immersed in a world of empirical fact; everything that a myth encompasses (magic, gods, miracles) may exist but is not touched upon in Lewis' novel. Instead, Lewis attempts to reconcile myth with "real things" which explains the tension between reason and imagination throughout the book. (Schakel 111)

The Development of the Romantic Fairy Tale: Beauty and the Beast

The type of comic romance to which 'Psyche and Cupid' belongs is a compilation of translated stories that are now know only through later retelling. "The connection of old women's speech and the consolatory, erotic, often fanciful fable appears deeply intertwined in language itself, and with women's speaking roles, as the etymology of 'fairy' illuminates." (Warner 14). Thus, the concept of the 'fairy tale' emerges through recycled and evolving retellings.

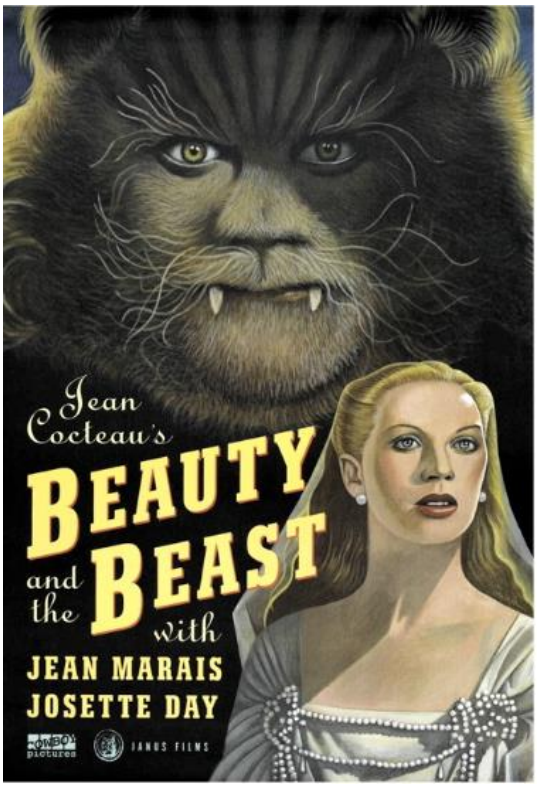
Beauty and the Beast has manifested from Apuleius' version to encompass the woman's voyage of inner discovery. "The demotion of the god who takes on human form and is imagined to be a beast, to a real beast who is an enchanted human being, has retained intact the successful form of the original story that has significantly diluted its deeper meaning" which is "[the] loving

encounter between persons whose natures, whose level of being, are fundamentally different (Accardo 86). Simple put – Beauty is a human girl and the Beast is an animal, yet they learn to love one another. This manifestation of man to Beast can be seen in the emergence of Madame Leprince de Beaumont's famous rendition of *Beauty and the Beast* written during the mid-eighteenth century." (Warner 297)

The fairy tale *Beauty and the Beast* deviates from both Apuleius' myth and Lewis' novel in that Psyche's lover is *not* a beast. He is only concealed from her. She is actually wrong to fear him. In many ways "the inner structure of the Beauty and the Beast tale reverses the roles defined by the title – she has to learn the higher (human) wisdom of seeing past outward appearances, to grasp that monstrousness lies in the eye of the beholder, while the beast turns out to be irresistibly beautiful and the highest good." (Warner 275) The myth of Cupid and Psyche has a deeper meaning lying under the simple story: "The name [Psyche] invites such a response, of course. Psyche is the Greek word for "soul"; the story from the first has been allegorized as the human soul's quest for love." (Schakel 5) The fairy tale *Beauty and the Beast* on the other hand is *not* allegorical and instead focuses on the female audience of the time.

"Romance – love in marriage – was an elusive ideal, which the writer of the *contes* sometimes set up in defiance of destiny … The fairy tale of *Beauty and the Beast* assumed a female audience on the whole who fully expected to be given away by their fathers to men who might well strike them as monsters. The social revolution which has established both romantic and companionate marriage as the norm irreversibly altered the reception of such romances, and

ironically transformed certain women's examination of their matrimonial lot into materialistic propaganda for making a good marriage. (Warner 278)



Jean Cocteau's Beauty and the Beast (1946)

Further, Cocteau's film *La Belle et la Bête* (1946) concentrates on awakening Beauty to the goodness of the Beast; "she has to see his unsightliness to the gentle and loving human being trapped inside." (La Belle et la Bête, Warner 295). The beast's anthropomorphic shape in the film, half man and half human, intensify the Beast's pitiful dilemma: his male desires deserve the reciprocating love a woman who would see past their eyes and listen to their heart.

The film concentrates on "men's anguish in the face of female indifference, on the tenderness of masculine desire and the cruelty of the female response, rather than women's vulnerability to male violence." (ibid, 296). The mysterious femininity of the enchanted castle serves as the counterpart to the Beast's savage masculinity. Without its feminine counterpart, the Beast cannot survive,



La Belle et la Bête (1946)

Interestedly, at the end of the movie, when the Beast is turned back into a man his human face is the same as the former rejected, aspiring lover Avenant. "So *La Belle et la Bête* traces a promise to male lovers that they will not always be rejected, that human lovers, however profligate, can be saved," (ibid. 297). Mmme. Beaumont's telling of Beauty and the Beast (of which *La Belle et la Bête* is based) has inspired the idea of female love and sympathy saving the man from the beast inside of him. To this day it continues to

inspire; however, I suggest that because historical context changes with time, so much must the tale change.

Alternatively, Betsy Hearne states, "the conditions determining the fate of Psyche and Beauty are totally different: Beauty's is a test of the perception of the heart and mind, while Psyche, repeatedly characterized as simple of mind, is tested to blind obedience …" (Hearne 11). In Jessica Tiffin's book Marvelous Geometry, she goes into length of the interchangeability and a lack thereof of myth and fairy tale. She touches on Max Lüthi's work and his formalist theory of '*isolation*' in which fairy tale figures are separated from any background or context. "Their psychological processes are not illuminated: only their line of progress is in focus, only that which is relevant to the action," says Lüthi (qtd. Tiffin 15). Ursula Le Guin furthers this idea in her discussion of Jungian archetype in fantasy. She argues that, "in fairy tale … there is no 'right' and 'wrong,' there is a different standard, which is perhaps best called 'appropriateness' … Under the conditions of fairy tale, in the language of archetypes, we can say with perfect conviction that it may be *appropriate* to [push an old lady into an oven]." She is suggesting why fairy tales (or we should say certain mythic motifs) survive over time and throughout a wide range of cultures.

That said, at the same time fairy tales are difficult to read symbolically because it is not an allegory. It *derives* from the allegory. The motifs, rather than meaning something specific, have resonance with the reader. Ursula Le Guin puts this another way: "a symbol is not a sign of something known, but an indicator of something not known and not expressible other than

symbolically. [Students] mistake symbol (living meaning) with allegory (dead meanin)" (qtd. From Tiffin). There may be allegory inside the fairy tale, but as Gay Clifford puts it, "the allegorist wants to communicate certain generalized formulations about the nature of the human experience … and shapes his narrative so as to reveal these." (qtd. From Tiffin 16)

In review, the tale of the Beauty and the Beast has had specific significance throughout the ages. In mythological form it is a tale of the soul's quest for love. As we progress in time there is a search for deeper, psychological meaning within the myth. C. S. Lewis attempts this in his novel *Till We Have Faces*. In large part he succeeds as we get an insider's look into the why and how of the original myth. However, we miss out the omniscient point of view that the original myth provides. Lastly, there are the fairy tales that derive from the myths and allegories. Fairy tales constantly adapt to the historical context around them. They take the bits and pieces from the original myth in order to make a familiar tale that will resonant with current audiences.

An interesting study and/or observation would be to look at a pocketbook and modern romance (e.g. Harlequin Romances, Silhouette Romances, popular suspense novels, etc.).



Harlequin *SuperRomance* from 1990's

The bad boy who's in touch with his 'inner beast' is a constant attraction to females who believe they can 'tame' him. Could this be a modern rendition of Beauty and the Beast"

It could be …

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Roses of Mexico City by Gary McCrae

[**San Francisco**] During the early 1960's, this city the ancient capital of Mexico was in the throes of expansion. A population of eight million destined to overflow to 24 million by the mid-1990's.

The metro is built upon the old city of the Aztecs – a very slow process for artifacts – whole palaces and ancient temples are being unearthed which adds to the archeology of this magnificent and intriguing city.

Over the foundation of the largest Aztec pyramids had been built the grand Roman Catholic Cathedral on the plaza known as the Zócalo. This area was also bordered by the Presidential palace – the Municipal Council and the balconied town houses of the Colonial aristocracy. Southeast of this great plaza and behind this immediate area lay the huge wholesale market place *La Merced*, where fresh vegetables and flowers were brought in from the vast countryside of Mexico.

This large metropolis now known as Mexico City had since 500 A.D. been known as Teotihucéan, and then had a population of 100,000 people sprawled over twelve square kilometers, an area even larger than Imperial Rome.

The Toltecs took over from the Teotihucéans, followed by the Tepanecas and it was they who allowed the Aztecs that had migrated down from the north to settle in what is now known as the Chapultepec district. This district of

Mexico City is now situated at the end of the Reform boulevard situated down from the Alameda.

From this area they had been subdued and then removed by a neighboring tribe. The Aztecs fled to an island south called Tenochtitlan and their settlement there in 1325 is now considered the official founding date for Mexico City. Eventually the Aztecs tied this island with an irrigation canal back to the district originally settled in Chapultepec.

My first introduction to this ancient city was by plane on an early January evening with a myriad of sparkling lights below. Upon landing we were driven through the teeming streets of Mexico City with vibrant humanity overflowing from all around. Ensconced at the *El Presidente* luxury hotel on the Alameda with a Diego Rivera mural overlooking the main lobby, this was an ideal place to set out, explore and discover this tantalizing Colonial city.

First on the agenda, which was the reason that drew me first to visit Mexico City, was a visit to the University of Mexico City. A few years earlier a wonderful offer had come my way which encompassed sending me to University for extended study of the history and arts for this area of the Universe. This offer was one I had never taken up and I was now anxious to visit and cover the campus. I had recently graduated from the world famous *Rudolph Schaeffer School of Color* in San Francisco and the recently attained knowledge would open up new vistas for me.

A few days later after my arrival and a visit to the grand floating gardens south of the city left over from the ancient Aztec civilization, I acquired from the hotel directions for going out to the University. This had sounded all very easy when the hotel had directed me to stand along the Alameda and step on a bus which would take me directly to the University. Upon standing for half an hour, I realized that all the buses coming I could not differentiate one from the next on the arrival of the continuing buses.

Hearing a young couple conversing in English, I stepped over and enquired if they could help me on which specific bus I should get on, but they were no help to me, as they were not familiar with the local numbered buses. Whereupon I saw a bus coming which seemed like the one I had been waiting for. As I readied myself for boarding I felt someone tap me on the shoulder and heard a voice saying – 'excuse me Sénor, this is your bus to the University.' Looking around I saw a lovely Senorita with extremely large dark eyes milling at me. I thanked her and proceeded to board the bus and immediately realized I could not figure out how much the fare would be. Instantly money was put in front of me, from behind me, and the same voice saying '*it was all taken care of Sénor*.'

The same Senorita was smiling beside me and I wished to immediately reimburse her, but she wouldn't take my money.

This was my introduction to Nora, for it was her way of getting to know me, and so we proceeded to sit and talk and the lengthy way out to the University of Mexico. This young lady had studied at the University's school of

languages and was an interpreter at the Hotel Alameda owned and operated by the Westin Hotel chain. She spoke fluent English and this gave her an excellent opportunity to offer me a sightseeing synopsis, when we arrived at the University. Of course I accepted and we had a most enjoyable afternoon going back and forth on the campus; admiring the grand mosaics on the tall towers and the lower buildings. It then became time for me to return downtown and she also decided to ride back downtown having long forgotten the reason why she to come out originally to the University. So we had another good visit to the old city near the old Presidential Palace and to show her my appreciation I invited her, and her sister (as chaperone) to join me that same evening for dinner. My invitation was accepted and we would meet at my hotel, which was conveniently situated.

In those years my wardrobe consisted of some beautiful and handsome suits which had been custom made for me in San Francisco (I should perhaps tell you I had bright red hair at the time). For that evening, I selected one of them in dark midnight blue, in beautiful fine wool serge bordering on cashmere; a perfect suit for dining out late evening in Mexico City. When the two sisters arrived they were both dressed elegantly. Nora herself had on a beautiful wool evening suit in deep grey trimmed with the black silky hide of the unborn café covering the front of her jacket – softer and finer looking than any velvet fabric. This was still legal in Mexico for the mother cow had to be killed to obtain the unborn calf, and it is not legal to be used or sold in the United States. We discussed various places for dinner and they both hoped we could all go to the Hotel Isabella, which was the most elegant hotel and the place for the *haute culture* people of Mexico City to be seen in. I already having

knowledge of this … but this didn't appeal to me, so I asked the sisters if they knew of a real and authentic restaurant nearby which served the fine cuisine of Mexico. Immediately 'Si' was there response as their father had recently – within the last week in fact – taken them both there. But … this would entail quite a drive to the distant outskirts of the city … which intrigued me even more. A sleek black limousine was summoned and we drove for miles from my hotel and arrived almost an hour later at the gates of what appeared to be a very elegant country club – perfect – with vast rolling manicured lawns amongst the trees and the grand restaurant was in a great sweep before our eyes – looking out over these great slabs of plate glass across the whole rambling colonial façade. While we arrived unannounced and had no reservations, the two sisters were acknowledged and we were ushered into a very large dining area filled with the most beautifully dressed people imaginable. Heavy linens were on each table, each touching the floor along with bright shiny silverware and heavy crystal. The waiters were all tuxedoed with none speaking English and the overlarge menus were all in Spanish – perfect!

I suggested to the two sisters that they make the menu selections for the three of us and to be sure and order plenty of whatever they wanted. 'Si Sénor – we will do just that!' We chatted and eventually their food arrived which was placed in front of us and it looked like wonderful authentic Mexican cuisine. My plate was then brought to me and it consisted of a very huge beef steak along with a very large pile of French Fries, for they had picked out a dish that they thought would make a young *Gringo* happy. Gringo means 'green' in Spanish, referring to the color of American dollars. This is why Mexicans

call Americans ‘gringo.’ I am actually a Canadian originally from Victoria, but had spent several years at art school in San Francisco. When it comes to Americans and Canadians, Mexicans don’t always make a distinction if you come from north of their border.

I really only picked at my food all the while stealing admiring glances at the two young women enjoying their meals. Hoping my disappointment did not show, I suggested they order several more Mexican dishes which we all three could share. This was done – one of the platters contained the most truly sumptuous chicken breast enchiladas I had ever tasted before or since that evening. Whole chicken breasts had been used inside, along with wonderful condiments for the stuffing. This was all perfect for me and it turned into a wonderful dinner of Mexican dishes. The dinner lasted several hours.

After dinner I suggested we could all go dancing. The sisters knew of a wonderful night club not too far from the restaurant, and so there we went. And authentic it was – another place for only very wealthy Mexican City citizens who really could afford and enjoy luxury. The club was huge, and along with Latin American music, there was a fabulous floor show. Across the full length of the stage was the largest xylophone I had ever seen stretching a good ten meters across with 20 to 25 musicians all playing on it at the same time – and what music it was. I can still hear it today in my memory; and what a good time dancing – to tangos, cha cha chas and rumbas – for the next three hours.

Now Mexico City at the time, (the early 1960's) did not have the great number of people it has today. It was a great deal less safe for foreigners to travel through than today. One did have to take into consideration ones' safety while moving about, especially if any distance was involved. Upon departing the night club that evening, the two sisters and I arranged for a cab to pick us up and I had completely forgotten to request that the driver be able to speak English, which is very mandatory in any foreign city. We left the night club with the sisters giving the driver instructions in Spanish and of course we would drop them at home first, and then I would go on to my hotel downtown afterwards.

The cab drove for miles as to my great amazement we ascended up the wall of the great plateau driving ever upwards and steeper for some distance. Arriving at the top, the sight before us was astounding, for there on top of this great expanse the most futuristic city one could imagine appeared– all floodlit before our eyes – along with a full moon beaming across the whole mirage-like scene. Skyscrapers jutting across – bridges joining them like freeways – all laid out in great order and palatial form.

The sisters ordered the cab driver with directions to where they reside, and when we arrived there with polite thank yous and goodbyes took their leave … and the cab proceeded on ….Almost immediately it came over me a great fear that this driver did not possibly speak fluent English and we were in the middle of nowhere … for within blocks we started to descend the plateau and leave the great vision behind us and we were in total darkness once again.

Almost with panic over me, I asked the driver if he spoke English with no response and continued in his slow and meticulous way. Nothing could be done but to hope he would drive me directly to my hotel for we were now in total darkness, with nothing but shrubs and trees on both sides of us. Suddenly out of the blue he started talking perfect English but not what I wanted to hear for he was marketing a lady of the night to me in most uncertain terms: the most beautiful girl in all of Mexico City for forty dollars and another one for much less, but she wasn't so pretty. My response was a sharp 'No!' which made him persist even harder, in fact so extremely persistent to where we were shouting at each – me yelling to be taken home immediately. At this point I was becoming fearful for I was dressed far too luxurious to be in such a situation.

We arrived at the bottom of the plateau in total darkness. Winding along a roadway we all of a sudden made an abrupt right angle turn in to an extended alley that appeared out of nowhere like it had risen out of the Earth. And … it might have come up out of hell … for there before me was a sight not to be believed.

The alley before me was lit with overhead lights which made it as bright as from the midday sun. It was here that I was looking at the night-world and a large portion of the netherworld of Mexico City. The length of three city blocks were teeming with people, filling that alley from wall to wall. As the limousine taxis wound its way t less than a snail's pace in this mob, they separated only enough to let the cab through. The whole scene before me was as though it had been lifted out from the filmmaker "Fellini" and his infamous

Italian movies. The most grotesque faces imaginable were passing my car continuously. Some were looking down in at me with faces pressed against the window peering right at me …They all looked liked drugged zombies and no doubt were … nothing in hell could ever possibly look worse. What a horror and bad nightmare for me and I was convinced the cab driver was taking me where he wanted to be in the beginning and I would have no say when presented to whatever underworld he wished to expose me to. These were, of course, all the night people of Mexico City, but it was the grotesque features on their faces that left the indelible mark on my memory. It seemed like an eternity to slowly wind our way through this teeming mass of sub-humans, all amassed in one alley. But suddenly we were out of it as quickly as we had come in to it and to my relief it was still dark but we were out of the alley! Ten minutes later we turned another abrupt corner and my hotel loomed up from the darkness. I was extremely angry – the cab driver had put me through an unnecessary ordeal, and as I was proceeding up the steps of my hotel, and I looked back he had the nerve to shout from his window – "Ah Sénor, why were you so afraid – I got you safely home."

The following day a call came to my suite from Nora as they had enjoyed so much the evening before and would I be able to accept an invitation to their home for dinner the following evening. It did race through my mind about a book my Mother had read me one summer when I was home. It covered Mexico City families and how they bring to their homes unsuspecting suitors for their marriageable daughters, and this could be the stage for a surprise wedding which they spring on them. Pushing these thoughts aside with the idea that I was old enough by now to handle such a situation and "yes, I could

come" – the limousine would be dispatched to pick me up at my hotel at seven in the evening. Now mother had always instructed me to always take along a gift to the hostess, and this would be what I would do. Enquiring at the hotel front desk where to purchase flowers, they directed me over to the great flower market *La Merced*, many blocks directly behind the hotel. Finding the market I was flabbergasted to see the acreage which covered every type of flower, including exotic blooms from the furthest jungles over far reaching corners of the country. One of the first stalls I encountered had the most magnificent long stemmed roses, and this I kept in mind as I wound through the many faceted stalls all the more wonderful than the last. This took several hours looking at it and admiring the most colorful and exotic blooms – orchids upon orchids – bromeliads all in the lushest colors, That I had ever encountered, but was drawn back like a magnet to those beautiful roses with stems up to four or five feet long.

Finding myself back at the rose stand, the old Mexican lady who owned it was busy with a number of different customers. While waiting I began wondering what the connotation of roses might be in a foreign country which I was not all that familiar with. Stepping over I asked a beautifully dressed lady in a very handsomely tailored camel hair suit about taking some roses to a hostess. 'Perfect,' she declared, so it was set – roses it would be – I would but a few of the wonderful magenta and orange pink ones which were absolutely breathtaking. Not figuring out the exchange and when the old lady was free, I stepped over and let her know I would but ten dollar American worth. Calling a grandson over to help her, they began to bring over bunches of roses much to their delight and the pile grew to around the height of my shoulders.

This was shocking to me, but hadn't realized what ten dollars could but at the time and at the same time I didn't have the heart to disappoint the old lady by telling her that I couldn't take all of them. But how would I get them back to the hotel? This the old lady solved easily by calling in five more grandsons to come and carry them, myself included, piled high with roses. The seven of us wound our way back to my hotel. What a sight it must have presented, not only many blocks back, but coming into the hotel lobby with such a mass of gorgeous roses. I had already decided I would request the hotel if they could hold them in cold storage for me until I would let them know I what I would do with them, for no way could these all be taken for a hostess of a dinner party.

Yes they would hold them for me until I would give them further instructions for their disposition. Arriving back to my suite, the telephone was ringing and on the other end was Nora with news of a change of plans. Her father was going to take us all for dinner to *el Villa Fontana* – one of the most outstanding restaurants in the city, as I had already known about and heard about this restaurant sometime before. This change of plans would be fine, for dining there would be a very rare experience, although I was somewhat disappointed to not have dinner in a Mexico City home. In the mean time my decision was just to leave the flowers with the hotel for now, and after everything was over I would give them instructions to perhaps place the rose in vases throughout the lobby.

During my stay in the hotel I made friends with an elderly, well travelled, couple from Oakland California who were somewhat perturbed hearing of

these new plans, with young and impressionable me being the centre point of such an elaborate meeting. They requested that I meet them early in the hotel bar for cocktails at their invitation. I sensed they were anxious with worry in their voices to meet and observe Nora and her family. They too heard stories of *matrimonial entrapment*. They were a darling couple – very elegant and were like a very fine ersatz grandmother and grandfather to me.

That evening we gathered for cocktails – dry Manhattan Martinis – at the end of the lobby, far away from the entrance. Together we were all seated where we could observe Nora's arrival. After our second cocktail what a happy time we were having when I saw Nora arrive at the front entrance of the hotel on the arm of her aristocratic father. And what an entrance it was. It stopped all traffic in that huge lobby. I waved and with a smile Nora spotted me. All eyes were upon this majestic pair coming across the floor towards us. She was dressed like a movie star, in a long black dress topped by a silk magenta opera cape flowing and billowing out to the floor with a slight train in the cape following in her footsteps. Her father was not exceptionally tall, but his regal bearing with an immaculate custom evening suit, complete with a black silk bowtie, carrying a beautiful golden headed cane topped the picture off like something out of a fairy tale.

They arrived over at where the three of us were sitting, chatting and I was busy introducing my friends all around when to my utter amazement I looked up and it was appearing like a mountain and a mirage moving over from the front desk. With a second look I realized that the head counterman had taken it upon himself and decided of course these were who the roses were for and

sent out six bellhops to carry them over and present them with great flourish to Nora. She was overwhelmed. Even her staid father staggered on his cane at sight a sight and no one was more staggered than I, and the first thing that came blurting from out of my mouth was "these are for your mother."

Nora smiled when I said this for she knew in her heart perhaps why I had said this. Nora's father, Mr. Riese, warmly thanked me for the roses. I took a liking to Nora's father immediately for it was very obvious that he was cultured and that he had old family connections to this ancient and sophisticated City. While we said our goodbyes to the Oakland couple, the flowers eventually were all loaded into the limousine. Then Nora her father and I – barely finding room in the limousine – were now on our unbelievable ride to *el Villa Fontana* on the regal stretch of Reform Boulevard. We were absolutely engulfed in these magnificent roses – in the fact the car was so packed with these beautiful blossoms that many were hanging out the open windows. People stopped in the street to watch us pass.

Our arrival at the restaurant caused a flurry. Exactly as the lobby of the El Presidente Hotel, the whole el Villa Fontana restaurant came to a complete standstill on our being led through the lobby and up the tiers of banquette seats to be seated right in the middle of the establishment – with all eyes upon us! In her arms Nora carried a few dozen of the roses. I suspect all eyes were on her and her alone, or perhaps her and her father. I sensed I was hardly noticed, except for perhaps my red hair.

Mon Dieu … what an evening … and it had just begun.

Now *el Villa Fontana* was famous not only in Mexico City, but the whole wide world over. The outstanding features beyond their superb cuisine was the strolling violinists of which each group consisted of approximately forty men playing the most romantic and beseeching music. Some of the music they played was Spanish, some Hungarian gypsy and some dreamy classical. Their musical reputation preceded them, and I had heard of their talents long before while I was in school in San Francisco.

While our waiter welcomed us to the restaurant and made arrangements to place Nora's roses in a silver vase on a small table, the musicians strolled over to serenade us. Such haunting music. I stole a glance around me. This restaurant was massive in size with extremely large isles to accommodate these groups of musicians strolling through and stopping to play at certain tables.

Out of the corner of my eye I could see that Nora's father was observing me closely, and that Nora was in turn observing her father. There was a triangle of sorts around the table. I should perhaps tell you that Mr. Riese either could not speak English or decided he would not. Nora did the interpretation and translation for us both. Besides I knew that people of consequence in Mexico know to learn and practice their English. I suspected at the very least Nora's father could understand English, so I knew to be guarded in what I would say to Nora. How did I know this? Well, it was in the lobby of the hotel when he father asked of me whether I was gringo … and he reacted ever so slightly – before Nora could translate for him – when I said "no I come from Canada."

The musicians played a short introductory set for us and then moved on and the instant they were out of ear shot, and before we three could say anything the waiter reappeared carrying the grand leather bound menus. Once again they were all in Spanish so once again I deferred to Nora and her judgment. When I did this Nora's father did the same, which I sensed surprised Nora. I could see her father being so aristocratic as to not let his two daughters make any decisions for themselves. Nora beamed with her culinary responsibility.

I decided to test this hypothesis and asked Nora how her sister was today. Nora looked up with big eyes, then toyed with the gold chain and cross around her neck before saying, "she wanted to come too … but papa thought four of us here for dinner would be a bit of a spectacle …" Then dutifully she turned and Nora translated what she had just said to me to her father. Her father said one word 'extravaganza …' and smiled over at me. Then Nora turned back to me and re-spoke the phrase "papa thought the four of us here for dinner would be a bit of a extravaganza …" I knew now it was best I not to tip the triangle.

The waiter returned and the order was given and then from almost behind the waiter – as if he was his shadow – the sommelier appeared, produced three wine menus for us and we set off to make the wine selection. Nora's father turned to his daughter and in Spanish said one word, and I knew what that word meant … 'Champagne?' Nora turned to me and asked me "would you like Champagne with our dinner?"

"Champagne was a bit sweet for my taste for the main course of a meal …" Nora turned to her father and explained. He closed his wine menu then he waved his hand at me and said something in Spanish.

"My father wonders if you can select the wine for our dinner."

There's a bear trap if I ever heard one. Choose a fine wine, but not an expensive one! Not a middling one but nearer the top end … I looked down at the jumble of Spanish words, then before I got lost in them a brilliant thought came to mind. I looked up and over at her and asked Nora "what have you ordered for us for dinner." As she explained in English I noticed the sommelier seemed uninterested. I was hoping he could understand English – but it was evident he couldn't. I had hoped to draw the sommelier into the decision making process, but I guess it was left to Nora and I to sort this out. She was game and so we discussed the dishes for a few moments then I asked her to translate for the sommelier. Without saying a word he pointed at a wine on the list. To my great relief it was neither inexpensive nor expensive. It was a Spanish wine I was familiar with. I nodded my head and said "si." The sommelier smiled his approval, as did Nora's father and collected up two of the three menus. Diplomatically leaving one at Mr. Riese's elbow. I guess the Champagne might come later. I had tipped-toed around that bear trap!

Then started the twenty questions … How we had met ? – as if he didn't already know for he probably had already given his daughter the 'third degree' – but I guess wanted Mr. Riese wanted to hear it in my own words. I was

careful not to mention Nora's boldness, nor imply that I was in active search for female company here in Mexico City.

He asked me what I did … then I sort of tripped up. I mentioned I had just finished art school in San Francisco …

"Artista?" The look of surprise on Mr. Riese's face brought a look of embarrassment to Nora's face. I knew she knew but I immediately suspected that she had not told her father this … Mr. Riese glared at Nora with the consternation of father thinking 'over my dead body …'

This brought a mix of feelings to my heart. On the one hand I was indignant that being an artist was considered so lowly by Nora's father, yet I also knew that I would not be invited to their home for a feast – wedding. I tried to keep a straight face but I suspect a bit of anguish showed on my face for Nora knew to ask "are you ok?" She again toyed with her necklace as she waited for my answer.

It was a sort of tell – her and her necklace. I smiled at her and simply said "art is what I seem to be best at …" She turned to her father and translated but once again I sensed he understood English for he immediately began to talk about the great artists of Mexico and Spain. It only took a few seconds for me to see that Nora was going to be fine (she stopped toying with her necklace) and while Mr. Riese talked about Valázquez and Goya I knew he was in his element. He made no mention of the modern Spanish artists like Picasso or Dali. It was if he was reciting a university lecture he once took in

Spanish Art History. I could tell Nora had heard this lecture before for she was quite bored.

Perhaps the talk needed some living up? I was about to mention the wonderful murals I had seen at the University when out of the corner of my eye I saw Nora raise he hand to her necklace. Both her father and I turned to her and we could both see the nervousness in her eyes. This was the dramatic moment of our evening! Nora sensed the danger. So I decided to forgo mention of the murals and started to talk about some of the religious Spanish religious icons we had studied at art school. A sincere look of relief passed over Nora's face.

I guess if I had mentioned the Diego murals I would be a rebel amongst the aristocratic and this would have ruined the ambience of our evening. Just as I was about to exhaust my limited knowledge of Spanish religious icons our meal arrived to save us from our awkwardness.

As the meal progressed I sensed a gathering seriousness in the tone of Mr. Riese's conversation with his daughter. The conversation was still through Nora's interpretation. Nora's father seemed very concerned with her about something serious and finally she turned to me and said her father was being insistent that I be told that her mother was not alive and he felt I should be told this as I had said that this was who the roses were for. Her eyes went stern for a brief second and I had to think what it was she was trying to tell me. The stern looked on her father's face told me that I needed to act ever so carefully.

“Do you like the roses?” I asked her.

“I do … very much … but my father says he would rather see they go to a favorite aunt of mine …” With those words I knew with certainty I would never be invited to a visit to their home. Again almost magically the next course of our meal arrived.

Nora in a coquette dig at perhaps the two men at her elbows had ordered me Oysters Rockefeller. Arranged on a large crystal platter set in shaved ice on an even larger sterling silver charger, were two dozen grand oysters.

She looked up at me and asked “Do you like oysters … or would you prefer snails?” She was a clever one, for just a few works before there had been a movie review article about a scene in the feature film Spartacus where a slave (Tony Curtis) asks his Roman Master whether he preferred oysters to snails …

I grinned knowingly at her. “I love eating oysters … and never touch snails.”

He father did not ask Nora what we had just said, so I just set upon the plate. The huge oysters were done in the traditional way of fresh spinach and cheese au gratin broiled over them. I ate one. It was the best oyster I had ever tasted and fresher than one could imagine. I offered Nora and her father to taste several of them along with what they she had ordered for themselves. Mr. Riese declined but Nora enthusiastically said she would. “I have never tasted

oysters before." Instead of daintily lifting the oyster out of its shell with a spoon she lifted the entire oyster to her lips and slurped it down, leaving a little drop of juice on her chin. She caught it with her hand before the drop fell on her magnificent dress. Her father said nothing but gave her a stern look of disapproval. In her rebellious mood she asked me for another. Nora's father shook his head slightly but all I could think of doing was shrug my shoulders. Nora enjoyed her second more than her first. I sensed she hoped I would offer her a third – but we had tempted fate twice already. A third time would be profoundly unlucky.

The wine matched their dishes but it did not match the oysters so I left my glass untouched and asked for mineral water instead. Sensing this miss match Mr. Riese ordered a bottle of Spanish sparkling white wine – champagne of sorts – the likes of which turned out to be a perfect match to the Oysters Rockefeller. Nora took a glass as well but Mr. Riese declined the pour by placing his hand over his glass and sternly warning the sommelier off with a few words in Spanish. The sommelier seemed a bit offended but set the half finished bottle between Nora and I into a large sterling silver cooler packed in ice. From time to time the sommelier took to stopping by and topping up our glasses. My glass was topped but once while Nora's was topped three times.

Then we dined leisurely with very few words shared. I knew that cultured dining in the Spanish speaking world was expected to last two or three hours. While we ate Mr. Riese went silent and all but left Nora and I to talk between ourselves. It was at that point that I knew Nora's father understood English,

for Nora was careful with what she said to me, and even how she said it, so we talked about what seemed like trivialities to me.

Nora asked me about my home and upbringing in Victoria and my time at the *Rudolph Schaeffer School of Color* in San Francisco. I in turn asked her about her growing up. And so a pleasant time was passed dining and chatting. No mention was made about her father and what he did and about her family, and her family fortune and the like. While I came from a well-to-do family, I had made sure I had avoiding mentioning anything too specific about my family and its fortune.

When the main dinner was over and before the dessert arrived, Nora excused herself to the powder room and this left me all alone with her father. Immediately the very cultured and well-mannered gentleman began talking to me in impeccable English with no trace of a Spanish accent. The fact that he spoke without an accent and impeccably was very profound, along with being utterly amazing!

I realized, until he had decided that he liked me, he would not converse with me directly. But now this point had arrived, and we had a very animated conversation. He told me that as a young man he had lived in California and had gone there from Mexico City to go to the University and had worked in *el Etats Unitas* for ten years before returning home where he had lived ever since. He expressed how much he liked me and the feeling was, of course, mutual. He offered me an invitation that upon a future return to Mexico City, as his guest he would take me and his two daughters on a tour through Mexico

starting at Toas the old silver capital and continuing through the country for six weeks; staying, as he insisted, at the most luxurious accommodations available. I said that I was honored and would love to take this trip with him and his family, whereupon Nora returned to our table with a look of astonishment. She was surprised that her father and I had hit it off so well – he was conversing in English with me and she was delighted.

After a very animate and lively dessert we took our leave of this very renowned restaurant. As we exited I cast one last glance from the foyer over this dream world and the elegant atmosphere cascading from the tiered baquettes – tuxedoed waiters – bright silver – tinkling crystal- superb music – soft illumination – I knew instantly that this had been an evening of privilege. Collecting Nora's dozens of roses we made our grand exit to the waiting limousine which whisked us back along Reforma – a full moon engulfing the sparkling city, with roses filling the car with their aroma – back to my hotel where I would take leave in the morning for many more weeks of my travel – both by air and by ship – before I would once again return home. It was with some sadness that I told Nora that I would be leaving Mexico City the following afternoon.

Early the following morning the sky was bright with sunshine and crisp with January air. I prepared to take my leave from this most colorful cosmopolitan city. As I stood waiting for a taxi to take me to the airport suddenly out of the crisp morning appeared Nora with some small keep-sake gifts for me. She was sad to see me go and asked me to write her and to come visit her again 'in the not too distant future.' It was awkward for me in that I hardly knew the young

lady and well, I had obligations elsewhere, including back in San Francisco. The taxis arrived and we took our leave, shaking hands. One of the souvenirs Nora gave me was a small Spanish translation book she once used which when I opened later at the airport revealed some of the rose petals from the night before, carefully pressed between several of the book leaves.

Weeks later, after many thousands of miles of travel, I arrived back in San Francisco in the grand luxury P & O ocean liner coming through the Panama Canal. Immediately when I arrived at my apartment the doorman told me of the many telephone calls he had been receiving from Mexico City. Hardly after I set foot in my apartment that the telephone rang. It was Nora calling to inquire about my trip and welfare. In a few days I started to turn them down for they had become collect calls on my telephone. Finally, some weeks later, a short note arrived in the mail from Mexico City informing me that Nora and her father had been trying to get in touch with me to invite me to come to a grand fiesta which was to be held at her aunt's ranch (that same aunt who got all the roses) near El Paso Texas. This was to be a fourteen day celebration – which I knew very often evolved into a wedding celebration with the unsuspecting groom becoming the main object of hundreds of celebrants who congregated from all over the world for the occasion.

Many years later I attended an evening special celebration in the very grand gothic Grace Cathedral on Nob Hill in San Francisco. Part way through the service I glanced across the aisle and there seated to the left of me was an exact replica of the young Nora from many years before. It was even

necessary for me to shake my head to look again, and be able to comprehend the vision before me.

At the end of the service I maneuvered to the beautiful young lady and the dark handsome fellow at her side. As we came through the grand and open magnificent bronze doors depicting the Gates of Paradise a beautiful full moon was bathing the whole top of Nob Hill in a glittering cover of radiance.

Striking up a conversation with the couple I discovered they were in San Francisco on their honeymoon and were staying at the old and very elegant Fairmont hotel just a block away. We talked about their visit to my city and how enthralled they were both to be here. As we arrived at the grand portico of their hotel I summoned the courage to ask the young lady what her mother's name was – Nora was the reply – and I assured her that she must and I was sure her mother also must be a beautiful lady. "Si Sénor" was the reply. 'My mother is the most gracious and famous hostess of all Mexico City.' Then the lovely couple turned and disappeared into the mist as they entered their hotel, and their future destiny which lay before them.

Out of mist of the night appeared the whole evening from thirty years before at *el Villa Fontana*. Was it a pang of guilt, or perhaps nostalgia? Was it the magic emanating from the moonlight – the mist – or combination of both? There before my eyes appeared Nora and her father, the many magnificent roses, the grand restaurant, the Oysters Rockefeller, the violinists with their beautiful and enchanting music, Nora in her grand majestic silk opera cape

with her gracious father with his gold handled cane, their stately grace – and both of them giving me a wonderful, vibrant smile.

The Naiad by Thorne Smith

Blending the fragrance of moist herbage with the scent of cocktails, Rex Pebble bore his sixty years along an uneven brick wall that led to a walled garden at the back of the house. And the moment he entered this quiet place the summer twilight claimed him. It was a spacious garden with fine turf pierced by the trunks of trees, and it sloped gently to the brow of a hill which lay without the walls, thus giving the spot a fair, broad view of the valley below and the villages nestling in it.

A long green pool, now glowing in the sunset, dreamed tranquilly within the garden and all day long reflected the changing moods of the sky. In the middle of the pool the statue of a naiad stood lightly poised on the surface of the water. A border of flagstones circled the pool, converging at the steps of a little white pavilion which stood partly hidden among the trees. This small but luxuriously appointed structure had been built essentially for privacy, which was just as well, for it had been the scene of full many a revel in those days when sixty years were an inconceivable distance off to Rex Pebble.

He gazed at the pavilion now, then certain memories forced him politely to avert his eyes. They rested on the statue of the naiad, and Mr. Pebble seated himself on a bench beside the pool the better to contemplate this wild nude figure.

For many years Rex Pebble had been contemplating this naiad, and for many years the naiad had been contemplating him with the same provocative smile

on her half-parted lips. He had given her the name of Baggage because he was fully convinced she was both saucy and promiscuous. And he liked her the better for it, although in his heart he chided her gently for her folly.

Baggage was a lush figure of a wench, the creation of vanished hands that either had known women too well or else had been deprived of them entirely. Certainly the stone had been caressed with desire and fashioned with a hungry ruthlessness that had left it a brazen challenge to the eyes of man. Yet there was something refreshingly honest and direct in Baggage's lack of modesty. Her seeming depravity sprang not so much from weakness or viciousness as from an ordered philosophy of existence – a desire to share with others the good things of life of which she herself was one of the best. If endowed with life Baggage would never be one of those women who tearfully proclaim, "I didn't mean to do it." Not Baggage. She would say instead, "Sure I did it, and if you don't watch out I'll go and do it again." Also, one would always know where to find Baggage. One would only have to look for the nearest man, and if there were two men, no doubt the other one would be waiting for her as patiently as possible.

These unedifying reflections upon the probable character of Baggage passed through Mr. Pebble's mind as his eyes dwelt on the lithe lovely lines of the full-blown figure.

He had found Baggage in a storage warehouse. She had been sold in default of payment for her keep. Yet even the dusty mantle gathered from her long incarceration had failed to rob her body of its wild pagan grace. Mr. Pebble

had an eye that automatically discounted the outer draperies of women in favor of what lay beneath. He had bought her on the spot.

“Wouldn't you like a sheet about her?" the man had asked when Baggage had been deposited in the back of the open motor.

"I might." Mr. Pebble had told the man. "In fact, I'm sure I would, but I doubt if the lady would like it."

Leaving the man a little shocked, Mr. Pebble had driven off with Baggage. Later he had presented her to his mistress. Since then she had become a part of the establishment, like Nockashima and the bloodhound. Mr. Henry.

With a slight start Mr. Pebble raised his snow white head, then shrugged his shoulders as if remonstrating with himself. Had those cocktails made him drowsy, and had his thoughts gone straying into the realms of pure fancy? Surely he had imagined he had seen the tawny, voluptuous form of Baggage step down from her little pedestal and come gliding towards him across the path of the slanting sun now flickering on the still waters of the pool. Surely he had imagined this, and yet- Mr. Pebble half rose from the bench and looked at the spot where the statue had been but where it was no more.

"My God!" he muttered. "Did the poor girl fall in? This is indeed a night of catastrophe."

"Sit down, old man," said a low voice beside him. "I didn't fall in the pool. I have come to pay you a long deferred visit."

Mr. Pebble resumed his seat. Quite calmly he accepted the situation.
"Hello. Baggage," he said. "I'm afraid you've come too late. I'm an old man now, as you have just reminded me."

He glanced at the beautiful figure beside him, then savored as if on the tip of his tongue the full bitterness of his years. There was something so imperatively urgent in the sleek young body of the girl sitting so close to him on the bench, Mr. Pebble felt that a just God should do a little something about it. Either the cocktails or the animal magnetism of his companion was making him a bit dizzy. His old, tired heart was thumping dangerously against his vest. That was it the doctor had told him about that heart-no excitement? That was it, no excitement. How absurd. If the doctor himself were here he would be fit to be tied. In fact, he would have to be tied if only for the sake of propriety.

The low voice was speaking again. "You were too busy when you were young to pay any attention to me," said Baggage. "'What were you always doing in that little pavilion down there?"

"You know all the answers." Mr. Pebble told her. "Hadn't you better let me get you some clothes?"

"And you know me better than that," said the girl, with a mocking laugh. "I never wore a stitch of clothes in my life. Why should I begin now?"

"Well, times are not what they were, my child," Mr. Pebble answered feebly. "Women wear clothes nowadays -not much of them, I'll admit, but still they wear a few."

"I wish you were young again," said the girl, fixing Mr. Pebble with a pair of wickedly disturbing eyes.

"Oh, how I do," muttered Mr. Pebble. "Don't look at me like that. It won't do you a bit of good, and it's upsetting me terribly. After all, I did you a good turn once. What's the idea now? Why are you trying to torment me?"

"I'm jealous," replied Baggage, "jealous of the youth you've lost. I want you back again."

"Listen, Baggage," Rex Pebble said earnestly. "Nobody wants to get back more passionately than I do, but you can see for yourself, my child, it just can't be done. There's no going back for me. I'm an old man now, with a heart too weak to hold its memories."

"Your memories would overtax the strongest heart," she told him; then asked curiously, "Has all desire vanished from your body?"

"Yes, my dear," responded Mr. Pebble a little sadly, "but not from my brain. That's what makes it so difficult to look upon you as you deserve-to estimate you dispassionately for what you are."

"And what am I?" asked the girl.

"A saucy, impertinent young wanton with a single track mind," he told her; then added reflectively, “Not that the track doesn't run through diverting pastures."

"You've said it, old man," replied Baggage commonly. “I need a spot of diversion."

"I'm afraid you won't find any here," said Rex Pebble, "unless you'd like to have me try to improve your morals."

"How can one improve what never existed?" Baggage wanted to know. "I never had any morals. That's why I've always remained an essentially honest girl."

"Perhaps you're right at that," observed Mr. Pebble. "Human beings are cluttered up with morals altogether too early in life. A wise providence should wait until our bodies are too old and weak to resent them – to get our backs up, so to speak,"

"How do you mean, get our backs up?" Baggage asked in a puzzled voice. She paused, then smiled delightedly. "Ah," she said, "I think I see. What an odd way to put it."

"You don't see at all," declared Mr. Pebble, "but you're quite right about having no morals. You remind me of my mistress."

"What!" exclaimed the girl. "That old ..."

"If you please," Mr. Pebble hastily interrupted.

"Oh, all right," said Baggage impatiently. "I'd remind you of all women if you only really knew them. At heart we're not nearly so refined as you men try to make us, and we know a lot of words. too."

“Don't I know!" replied Mr' Pebble. "Not only do you know a lot of words, but you also love to use them. My life has not been overburdened by too many refined women."

"Then you should know a lot of bad words I've missed," the girl said hopefully. "Tell me some."

Mr. Pebble looked really affronted.

"You'd better talk with my mistress," he replied a little coldly, "or better still, with my wife."

"I won't have any dealings with either of those hags," Baggage retorted. "They had all the youth of you. What have I got? Nothing but an old horrid."

"Why don't you join the army?" Mr. Pebble ungallantly suggested. "You should be able to get plenty of action there."

"I've had my heart set on you for years," said Baggage. "I hate to let you escape me."

She cuddled up closer to him on the bench and put a cool arm round his neck. "Heaven protect me," muttered Mr. Pebble. "If that woman of mine called Spray finds us together like this there'll be no escaping her."

"I hope she does," said Baggage. "I'd love to annoy her."

"I feared as much," said Mr. Pebble. “She is annoyed enough already."

"Are you?" asked the girl, burrowing her small nose into his neck just behind his ear. "You smell awfully clean. Why don't you take your clothes off?"

With a startled ejaculation Mr. Pebble broke the girl's strangle hold and slid along the bench to momentary safety.

"You can think of the damnedest things," he complained. "Let me point out this to you: I am a clean old man, and you are a vile young woman. We have nothing at all in common."

"I want to bite your ear," said the girl. "That is always a good way to start."

“Keep your teeth to yourself," Mr. Pebble retorted. “What are you thinking of starting, anyway?"

"Something in the nature of a seduction," sa.id Baggage. “That is, if you'll stop flitting about like some nervous old bird."

"I am a nervous old bird," replied Rex Pebble. "A very nervous old bird, indeed. Why can't you talk and be reasonable instead of mauling me about? You have even less consideration for a body than a professional wrestler."

"Then consider my body for a moment," said Baggage. “What am I going to do with it?"

"'Why don't you take it back to your pedestal, where it belongs?" asked Mr. Pebble.

"My body belongs with yours." replied the girl.

"Then it virtually belongs in the grave," said Mr. Pebble. "I'm going to fall down dead if this keeps up."

"Let's fall down together," Baggage suggested.

“BBy God!" cried Rex Pebble. "If I were twenty years younger. or even ten ...”

"Yes?" broke in the girl. "Go on. What would you do?"

"None of your damn business," said Mr. Pebble. "I'd teach you a lesson."

"How do you know you could?" Baggage challenged.

"By all that's holy." exclaimed Rex Pebble, now thoroughly aroused, "I will teach you a lesson if it's my last act in life."

He rose quickly from the bench, and ripping off his coat and vest in one ruthless movement tossed them to the flags.

"Hurry!" cried the undismayed Baggage encouragingly. "Stick out your legs and I'll drag your pants off'"

The hard-boiled ardor of the girl was too much for Rex Pebble. With a sudden revulsion of feeling he sank back on the bench.

"What a suggestion!" he muttered. "What a picture! Me with my legs stuck out and you dragging off my trousers. What do you think this is, a game?"

"Sure," replied Baggage. "You can keep your shoes on. I don't mind."

"I'd look crisp with my shoes on," observed Mr. Pebble. "Not to mention my socks and supporters."

"Who's going to worry about your feet?" demanded Baggage. "Snap off those pants."

“Snap them off?" repeated Mr. Pebble. "Oh, my word. Everything is all off. I am definitely beyond seduction."

"You're no such thing," cried the girl, flinging herself upon him and dragging out his shirt tails.

Once more the famous Pebble courage asserted itself. No woman was going to drag out his shirt tails. That was going too far. He rose from the bench and seized the girl by the shoulders. Mistaking his intentions she abandoned his shirt tails to the light summer breeze, and threw her arms round his neck. For a moment they struggled perilously on the edge of the pool, then Baggage with a low laugh wriggled from his grasp and sprang lightly away.

"Pist!" she uttered in a piercing whisper. "Look behind you!"

The water of the pool parted smoothly as the even smoother body split its surface. Like a flash of silver Baggage streaked through the green depths, then

dwindled and disappeared. Where had she gone? Rex Pebble wondered. Had the whole episode been a figment of his disordered imagination? Or had Nockashima mixed some curious Oriental dream-stuff in the cocktails? From cocktails to shirt tails was not a wide leap in thought.

Mr. Pebble took the leap. His shirt tails were out. They were playing havoc with the Pebble poise. That was not a question of imagination. It was grim reality. And equally real was the fact that Baggage, in the flesh, had dragged those same shirt tails from their tender concealment. An impulsive wench.

Mr. Pebble realized with a pang of regret that he could not stand there forever gazing into the pool for a last glimpse of that swift silver body. Baggage had withdrawn from life as remarkably as she had appeared. He hated to turn about and face his mistress. Nevertheless, it would have to be done, or she would do it herself by force. He sighed, and without any unnecessary ostentation, collected his shirt tails and tucked them out of sight. It was not a neat job, but at least he felt less like a flag.

Then slowly he turned his back on the pool and faced about to meet Spray Summers who, in spite of her feet, was bearing down upon him like a ship under full sail. Mr. Pebble noted with relief that the good lady appeared to be far more astonished than angry.

"A pretty way to be carrying on at your time of life," she announced. a trifle winded from the unaccustomed speed of her progress. "Tell me without even

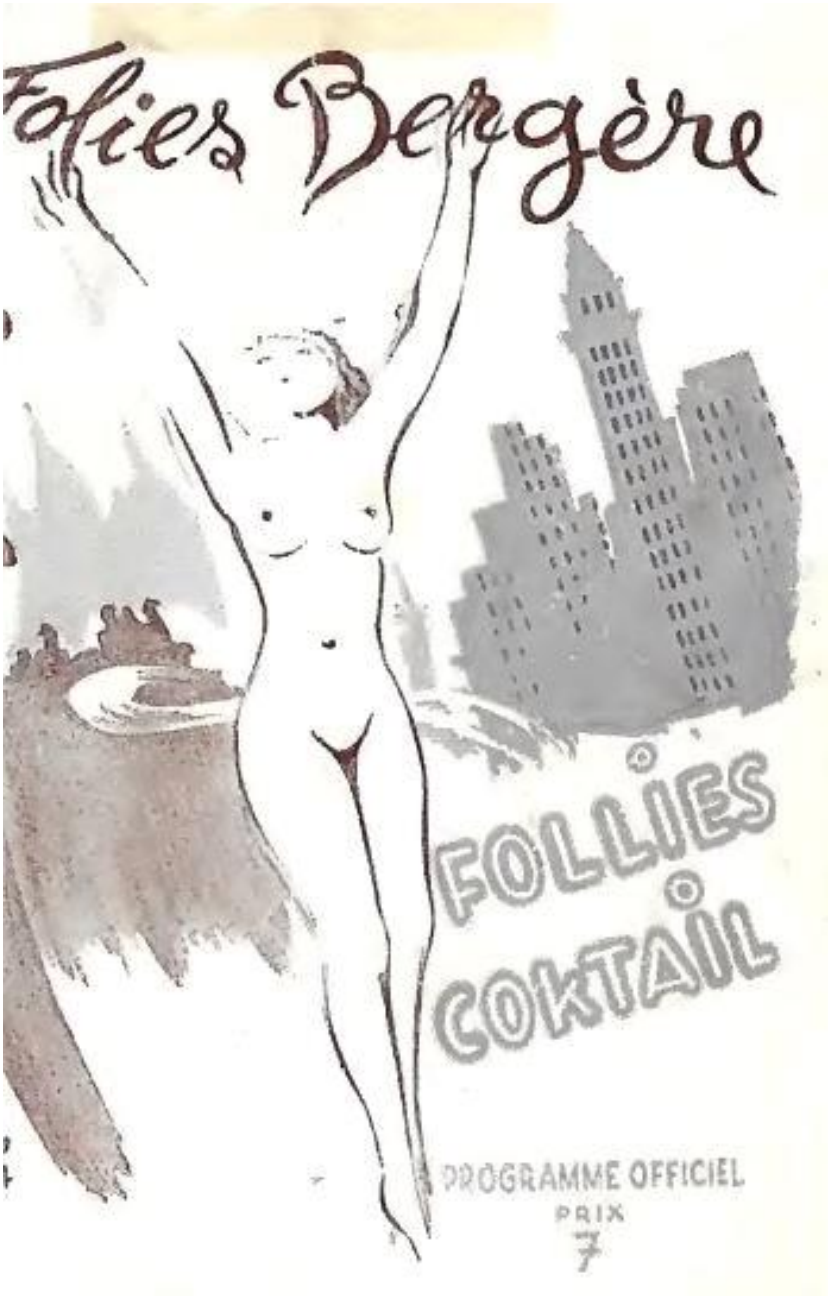
attempting to lie, you senile atrocity, just who was that naked trollop you were trying to assault before you chucked her into the pool."

"You've got your facts in reverse," said Mr. Pebble. "In the first place, the trollop was trying to assault me, and in the second place, she chucked herself in the pool the moment she saw you."

"Then why doesn't she come up," demanded Spray, "so I could give her a piece of my mind? Perhaps she's drowning. I hope so."

"It was Baggage," said Mr. Pebble. "But she's gone now. Look, Spray. The pedestal is vacant!"

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(First Act)

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(The re-opening)

A — EN MANIÈRE DE PROLOGUE *(As a prologue)*
B — AU BAR DES FOLIES-BERGÈRE *(At the "Folies-Bergère" Bar)*
C — LE FOLLIES-COCKTAIL *(The "Folly" Cocktail)*

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La commère de la revue. . . . . Mlles Lyne de SOUZA
La danse . . . . . MICHELINE
La chanson swing. . . . . Ginette WANDER
Le nu . . . . . Mlle Nicole ROY
et les Swing FOLIES GIRLS

L'HOMME AUX YEUX BLANCS
(The man with the white eyes)
Andy SILVIO

A LA KASBAH D'ALGER
(In the "Kasbah" of Algiers)

Ahmed . . . . . MM. PIROSKA
Pépé le Moko. . . . . AMBERTI
Maya . . . . . Mlle Nicole ROY
Le marin au foulard . . . . . M. Marcel LEBAS

ÇA C'EST PASSE UN DIMANCHE
This happened on a Sunday)

A — DANS LE LIT CONJUGAL *(In the conjugal bed)*
B — LA PHOTO DU PÉCHÉ *(The photo of the sin)*
Décors DESHAYS

La femme . . . . . Mlle Ginette WANDER
Le mari. . . . . M. Marcel LEBAS

SOURIEZ, MADEMOISELLE
(Smile, my Girls)
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Le chevalier Armory	MM. Gérald CASTRIX
Le bouffon	Gaston BRUYERE
Le diable	Lino CARENZIO
La gipsy	Mlles ILONKA
La chambrière	Simone IDY

et les Swing FOLIES GIRLS

TOUTE UNE NUIT A NOUS!

(A whole night to ourselves)

Le mari	M. DANDY
La femme	Mlle Ginette WANDER
L'amant	MM. Marcel LEBAS
Le fakir	AMBERTI
La concierge	Mlle Simone IDY
L'agent	M. Andy SILVIO
La bonne	Mlle LUCKY

UNE BELLE PORTÉE

(A fine litter)

Les Swing FOLIES GIRLS

LE COCKTAIL POUR LES AMIS

(A friendly cocktail)

La commère de la Revue . . . . Mlle Lyne de SOUZA

A — LE BALLET RUSSE : IDYLLE UKRAINIENNE

(The Russian Ballet - Ukrainian Idyl)

Le berger	M. PIROSKA
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(English Pantomine - On the sands at Brighton)

La jolie fille de Perth . . . . . Mlle Ginette WANDER
Le horse-guard . . . . . MM. Gaston BRUYERE
Le marin . . . . . Andy SILVIO
Le highlander . . . . . Marcel LEBAS

C — LE FILM AMÉRICAIN : BROADWAY'S PANOPLY
(American film - Broadway's Panoply)

La star d'Hollywood . . . . . Mlle Gizy VARGA
et les Swing FOLIES GIRLS

DEUXIÈME ACTE
(Second Act)

LA FORÊT VIVANTE
(The Living Forest)

A — LA SOURCE AUX BICHES *(The spring of the deer.*

B — LA CLAIRIÈRE BLANCHE *(The white clearing)*

La biche aux bois. . . . . Mlle Gizy VARGA
Le chasseur. . . . . M. Lino CARENZIO
et les Swing FOLIES GIRLS

NUITS DE PARIS
(Nights of Paris)

A — RUE PIGALLE *(Pigalle Street)*

L'entraîneuse de boîte de nuit . . . Mlle Ginette WANDER
Le clubman . . . . . M. Gérald CASTRIX
La fille . . . . . Mlle Nicole ROY
Le marlou . . . . . M. AMBERTI

B — UN HOTEL PARTICULIER AU BOIS
(A Private mansion in the " Bois " - Boulogne Park)

Le mari. . . . . M. Marcel LEBAS
La femme . . . . . Mlle Gizy VARGA
L'inconnu . . . . . MM. Lino CARENZIO
Le valet de chambre . . . . . Paul JOVY

UNE GARDEN-PARTY CHEZ LA PAÏVA

(Paiva's garden-party)

La Païva	Mlles Lyne de SOUZA
Rigolboche	ILONKA
Le capitaine des grenadiers de bois	PIROSKA

et les Swings FOLIES GIRLS

LA CAGE D'AMOUR

(The love cage)

La petite fille de Shéhérazade	Mlles Simone IDY
L'oiseau des îles	Nicole ROY
Le prince persan	REGINA

QUELLE MODE PRÉFÉREZ-VOUS?

(Which fashion do you prefer ?)

A - CELLE-CI ? *(This) ?* — B - OU CELLE-LA ? *(or That) ?*

Le couturier	MM. Gérald CASTRIX
Le caïd	Gaston BRUYÈRE
1re cliente	Mlles Lyne de SOUZA
2e cliente	Simone IDY
Le groom	M. Paul JOVY

et les Swing FOLIES GIRLS

DANDY CHEZ SON TAILLEUR

(Dandy at his tailor's)

Bonasse	MM. DANDY
Le tailleur	AMBERTI
Le garçon de magasin	Paul JOVY

LE BAISER DE PARIS

(The kiss of Paris)

Le Parisien	M. Gérald CASTRIX
Le sourire de Paris	Mlle Lyne de SOUZA

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Surrealist Female Monsters by Sylvie Pantalacci

According to Gerard Durozoi and Bernard Charbonnier, surrealist ethics are based on two phenomena that gathered momentum as world movements at the beginning of the twentieth century, the emancipation of women and the continuing development of a science of the unconscious. [1] Since either had the potential to change the established moral and social values of their contemporary society, the surrealists viewed both phenomena as *Revolutionary*. And both had other common elements: Women's demands included the right to sexual freedom, and psychoanalysis was the first intellectual movement to stress the importance of erotic desire in everyday life. The combination of these two revolutionary ideas led the surrealists to a new view of women. The traditional dichotomy, virgin or prostitute, was replaced by another dichotomy, child-woman or femme fatale.[2]

According to surrealist theory, the child-woman is a wonderful fairy, a mediatrix whose essential function is to lead man to a higher state of knowledge and happiness. But she cannot fulfill this function unaided: Unaware of her power, intuitive (a female quality) but not analytical (a male quality), she must wait for the man in her life who will reveal to her … her extraordinary capabilities.[3] Xavidre Gauthier notes the contradiction inherent in a so-called revolutionary theory that considers a woman to be a child, and thus places her in such a traditional state of dependency. [4] In this male vision of the cosmic roles of man and woman, man is the instigator of woman's emancipation, which is to serve his ends, effect his salvation. Another

reactionary aspect of this surrealist concept is a complete sacralization of women reminiscent of the Catholic concept of the Virgin Mary.[5]

The negative side of this surrealist dichotomy is the femme fatale, the woman whose sexuality attracts and destroys men. This image too remains almost identical to one view of women held for centuries by the Catholic Church, and reveals the same fear of a female behavior that does not fit the established patriarchal pattern of right and wrong. In theory, as in artworks springing from this theory, the image of woman is a dichotomy whose opposite sides each reveal a deeply reactionary perception of sex roles.

While the "positive" image of the child-woman is elaborated more frequently in theoretical and poetic works, the femme fatale is more often portrayed in surrealist paintings. [6] Rene Magritte's *La Gâcheuse* and *L'Espirit de la géométrie*, Salvador Dali's cover for Minotaure No. 8, and Joan Miro's *Tête de femme* similarly demonstrate the surrealists' negative image of the femme fatale by depicting frightening, monstrous heads appended (usually) to attractive female bodies. These paintings were created in the 1930s – when, after several years of internal conflicts and crises, the surrealist movement attained a theoretic stability and established more widely accepted definitions with the second *Manifeste du Surrealisme*, the departure of such dissident members as Robert Desnos, Jacques Prévert, and Louis Aragon, and the arrival of Dali, Louis Bunuel, and others. Such expression of fear and hatred of woman in art is not limited to this decade; it is an age-old, recurrent theme that will be developed or reused later tby the surrealist painters and other artists. But the essential strength of the surrealists of the 1930s lay in their

innovative and conscious depiction of desires and phantasms identified as such by the artist-and presented as such to the viewer-through the application of psychoanalytic theory to the work' Similar material up to that time had been considered relevant only to the analysis of dreams and madness. The surrealists intended through their imagery to send a message from their unconscious to that of their audience through such a well-controlled, technically refined artistic vehicle as, for example, Dali's paranoiac-critical method.

For this reason, reference to the Freudian method of dream interpretation is appropriate for the analysis of these surrealist works. The monstrosity of the women represented in these paintings lies in the simultaneous presence of contradictory elements, some attractive-nude breasts or legs, seductive poses and others repulsive and/or threatening. Freud notes that it is the "custom" of dreams "to take both members of an alternative into the same content, as though they had an equal right to be there," and to ignore "antithesis" and "contradiction." [7] In applying the same principle visually, surrealist art can illustrate a mechanism operating exclusively within the domain of the unconscious, one whose rules allow for an irrational twisting of meanings and the violation of classically accepted logical formulation; thus, for example, contrary to Aristotle's law of the excluded middle, a depicted object could have both female and non-female elements at the same time.

A common detail among these selected paintings, the representation of nude breasts, emphasizes woman's maternal aspect; some works do not even show the full body, but truncate it under the chest (Magritte's *La Gâcheuse* and and

L'Espirit de la géométrie, Miro's *Tête de femme*). Magritte's *L'Espirit de la géométrie* (Fig. 1, 1937) represents a typical mother and baby composition, the woman holding her infant in her arms.



Fig.1: Rene Margritte *L'Espirit de la géométrie*, 1937

However, the painting shocks the viewer by placing the heads on the wrong bodies; the concomitant inversion of proportions (the juxtaposition of the enormous, bald baby's head and the small, longhaired mother's head) also suggests an inversion of roles, that the child protects and nurtures the helpless adult. This radical inversion corresponds to another inversion recognized in psychoanalytic theory, the transformation of the powerful, good, nurturing, mother (the good phallic mother) into a terrifying mother who overfeeds her baby (the bad phallic motherl.[8] This inversion could also express a phantasm

of reversed orality in which the nurturing mother is transformed into a monster who will eat her child, a recurrent theme in mythology.



Fig.2: Rene Margritte *La Gâcheuse*, 1935

Another element common to these pictures and related to the motif of orality is the emphasis Miro, Magritte, and Dali give to teeth. Teeth may symbolize different phantasms depending on their contexts. For a child in the oral phase, they can be reassuring within the context of the phallic mother, who is perceived as phallic because the child assimilates the tip of the breast as a penetrating penis during lactation. The phallic mother can also be perceived negatively, as distressing, when she overwhelms by force-feeding her baby; the child can then use teeth as defensive weapons to stop this unpleasant situation. Teeth may sometimes be phallic symbols of fertility, but they are

usually associated with fear of castration. The skull's teeth in *La Gâcheuse* (Fig. 2, 1935) look as sharp as a guillotine. The title of this painting ("the spoiler," "the troublemaker") suggests that Death, the despoiler, supplants beauty and love; but it could also imply that destruction is a corollary of love, that there is a castrator in every woman.[9]

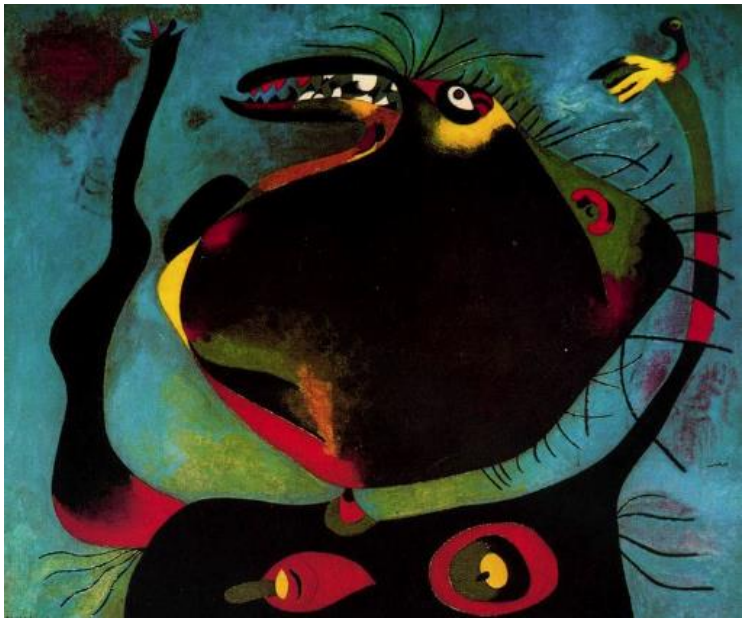


Fig.3: Joan Miro *Tête de femme*, 1938

In Miro's *Tête de femme* (Fig. 3, 1938), as in Dali's Minotaure, the phallic shape of the threatening mouth (beak or muzzle) can evoke fear of castration. Miro's painting recalls Max Ernst's *L'Ange du foyer* (Fig. 4: 1937), which represents a monstrous creature dancing. Her mouth is another beak with teeth, and her arms are raised in the same movement. Either figure would probably grab and devour an unfortunate passerby. Dali's monster is even more terrifying. Even though the body's attitude is seductive, the image's central point of focus, the groin, is guarded by a castrating, snappish lobster

that hangs above the genital area to forbid any sexual approach. This is a representation of a common phantasm, the *vagina dentate*: Robert Gessain notes that some are fearful that sexual penetration can lead to castration because of teeth (or razor blades, etc.) concealed within a woman's gentialia. [10]



Fig.4: Max Ernst *L'Ange du foyer*, 1937

The *vagina dentata* is also suggested by the interchange of higher and lower parts of the body, such as a mouth with teeth for a vagina. In Magritte's *The Rape* (Fig. 5), parts of the female body constitute the woman's face: Breast, navel, and pubic hair represent the eyes, nose, and mouth.

The image of woman in these paintings is neither flattering nor original. The paintings convey to various degrees a common *vagina dentata* phantasm, a particular aspect of the castration complex. Yet such paintings sometimes

present a temporary relief from this fear by immobilizing the woman's sexuality.



Fig.5: Rene Margritte *The Rape*, 1945

This is especially evident in Magritte's *L'Invention collective* (Fig.6: 1934). The creature stranded on the shore appears to be the contrary of a mermaid: The upper part of her body is that of a fish; the lower part is human. She just lies on the sand, completely helpless. In that respect she is a surrealist collective invention rendered passive-as well as repulsive-by an incorrect mythological rearrangement. Another example of the painting immobilizing woman's sexuality is Brauner's *La Ville*. A staring woman dressed in black seems to float in the air; light falls on her face, breast, and genitalia, emphasizing her womanhood. But the little snake-spermatozoid in the

painting does not dance in front of her; it is attracted instead by another, (h)armless, sleeping female. Here, active female sexuality is acknowledged but remains somehow unenticing because of its dangerous absence of controls; the less threatening female figure, asleep and literally disarmed, is preferred.



Fig.6: Rene Margritte *L'Invention collective*, 1934

According to Gessain, the interest of the *vagina dentata* myth lies in its initiatic strength: Through confronting it, one can dominate this fear and reach a good understanding of woman. [11] But this positive phase does not seem to have been reached within these paintings per se: The female surrealist monster, either dangerous or crippled, is alienated from and by male painters. As in the traditional ideologies whose reactionary attitudes the surrealists ironically reproduce, any productive association with this monstrous "other" and its different sexuality remains impossible at the Practical level.

NOTES

1. Gerard Durozoi and Bernard Charbonnier, Le Surréalisme: théories, thèmes, techniques (Paris: Larousse, 1972), p. 175'

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3. Robert Benayoun, Erotique du Surréalisme (Paris: Pauvert, 1965), pp.162-174.

4. Xavidre Gauthier, Surréalisme et sexualité (Paris:Gallimard,l97l)' pp. 111, 149-151.

5. Ibid., pp. 145-155.

5. Ibid., pp. 331-333'

7. Sigmund Freud, The Interpretation of Dreams (New York: Random House, 1950), pP. 207-208.

8.Robert Gessain, "Vagina Dentata dans la Clinique et la Mythologie," La Psychoanalyse 3 (1957):277'

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{First published in the book, *Eros in the Mind's Eye*, 1986}

Sex in Surrealist Art by Francine A. Koslow

Surrealism began as a literary movement in Paris in 1924, when poet André Breton (1896-1966) published his First Manifesto of Surrealism. Breton, a former student of psychiatry, defined the movement as "dictated by thought, in the absence of any control exercised by reason, exempt from any aesthetic or moral concern." [1] Surrealism, as defined by Breton, was based on belief in the omnipotence of dreams and the unconscious. The active collaboration between surrealist artists and literary figures that followed Breton's manifesto resulted in visual works that deal with hitherto unexplored phenomena, including enigmatic sexual fantasies. Eroticism in art has been around since prehistory. Fertility goddesses and Greek phalluses were common early art objects. Yet these images were extensions, however explicit or exaggerated, of objects in the real physical world. Surrealists deal specifically with distortions and the irrational. Their eroticism, however explicit, explored subconscious, uncontrolled realms, bizarre domains that were almost uninvestigated prior to the advent of Freudian psychology.

The surrealist painters and poets centered their activities in the late 1920s around Paris and Breton. Their art was based on humor, subversion, and dream. Confronting a postwar world of disintegrating social, cultural, and economic mores, the sur realists were rebels who embraced the absurd, the accidental, and the illogical in order to open doors of perception previously closed by rational thought. Among their heroes was Isadore Ducasse (who used the pseudonym "the Comte De Lautremont"), a late nineteenth-century symbolist writer who promoted the juxtapostion of disparate objects.

Lautremont's symbolic image of the chance meeting between a sewing machine and an umbrella on a dissection table stimulated the surrealists to place unrelated objects together on the picture plane. The impact of the surrealist image lies in this dissociation of objects from their familiar contexts.

The surrealists also chose to embrace the illicit and often dark side of human nature. Under Breton, they canonized the Marquis de Sade and invented a cult of love that elevated libertinism. They employed Sigmund Freud's method of evoking repressed material through free dream association and took greatest interest in the psychiatrist's theories on sex (Eros) and death (Thanatos). The surrealists expressed their opinions freely on such matters as female orgasm, onanism, and sadomasochism and other sexual perversions, and often made sex the subject of their work. Artists like Max Ernst (1897-1976), Ren6 Magritte (1898- 1967) , Salvador Dali (b . 1904) , and Paul Delvaux (b. 1897) created artworks that shocked on two levels, the candor with which they depicted sexuality and the odd juxtaposition of subjects and objects that do not belong together in the rational, real world.

Alfred Barr states in his pivotal 1936 exhibition catalogue titled Fantastic Art, Dada and Surrealism that Surrealism grew out of the ashes of Dada. Dada, an anti-art movement, claimed the German artist Max Ernst as one of its leaders. Ernst made the transition from Dada to Surrealism when he moved to Paris in 1921 and met Breton and his followers. A leader of the Hanover Dada group that had held the infamous Cologne International Exhibition in a men's urinal, Ernst appealed to the rebel surrealist spirit. He had studied psychiatry and philosophy at the University of Bonn and, having shared quarters with

Breton's close collaborator, Paul Eluard (b. 1895), was immersed in the world of dreams and the unconscious. As an artist Ernst became fascinated with the collage technique of cutting and pasting objects together in unusual combinations. His collages anticipated Surrealism in their subject matter and technique. When Breton chose Ernst as a welcome member of his Paris coterie, he was well aware of the impact of such works as Ernst's 1923 oil painting titled *Men Shall Know Nothing of This*.

Men Shall Know Nothing of This is an enigmatic coital image in which the two sexes balance each other in curious symmetry. The dreamlike composition appears to have been pasted together and linked with strings. The space is that of another dimension of reality reminiscent of the metaphysical paintings of Giorgio de Chirico, an artist revered by Ernst and the surrealists in the early 1920s. The upper region of the composition is dominated by two sets of amputated lower extremities locked in the sex act. Two female legs, spread in a froglike pose, are penetrated from above in what appears to be the anal or abdominal region by the male legs, which are joined at the thighs. The erotic legs are pierced at the feet by the umbrella like arch of a new moon. They float above a disembodied hand that penetrates a ring and a whistle. Geometric configurations resembling a concentric ring of planets or the phases of the moon surround the hand. These seemingly unrelated parts exist in a landscape dominated by two large trapezoids topped with circles, possible symbols of the male and female. The ground beneath exudes visceral, biomorphic forms. The disembodied, floating images are images of metaphysical, interplanetary sexuality.

The title indicates that ordinary men shall know nothing of Ernst's metaphysical fantasy, which exists only in the recesses of the unconscious mind. Ernst's painting forms a solid link between the metaphysical art of de Chirico and surrealist illusionism. It is an abstract dream image of obscure meaning.

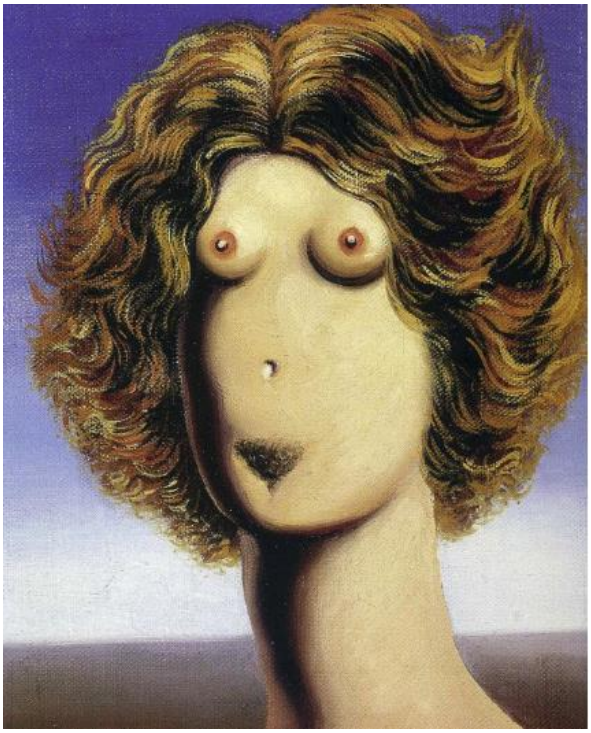


Fig. 1: René Magritte, The Rape

In late 1925, the Belgian painter René Magritte created a surrealist image based on dreamlike illusionism. The originality of Magritte's image lies in the secret affinities between seemingly dissociated objects. Magritte's style is consistently that of precise, magic realism-the realistic presentation of what appears to be an ordinary scene, without any strange or monstrous distortion, that nevertheless contains fantastic juxtapositions of elements or events that

do not normally exist together. Magritte painted *The Rape* (Fig. 1, 1934) in Brussels, and Breton chose Magritte s drawing of the same subject for the cover of the 1934 surrealist publication Qu'est-ce que le surréalisme.

The painted version of The Rape was included in the 1934 surrealist Minotaure exhibition in Brussels, where it was hung in a private room at the back and shown only to initiates. The exquisitely detailed painting is a highly Freudian sexual metaphor that combines a female head and nude female torso in a visual pun. The face's features are replaced by breasts, belly, and pudendum. Breasts and nipples replace the eyes, the navel becomes a nose, and the pudendum is the figure's mouth. This comical monster rises sphinxlike against a blue sky and sea. Magritte habitually appended unrelated titles to his works, and this title has no apparent relation the the comical trompe l'oeil image; there is no rape or violence in The Rape. Magritte's initial artistic concern is to reconstruct the female torso with absolute fidelity to anatomical detail inside the frame of the female head'

Metamorphosis and the constant fluctuation of objects from their ordinary contexts characterize the good-humored sexuality of Magritte's art. In another visual pun, La Dame, Magritte places a nude blonde inside a bottle of wine. Magritte's carefully rendered portraits of nude women isolated from their normal ties with the rest of the visual world are bewildering and beguiling erotic compositions.

Salvador Dali, more than any of the other surrealists, relied on Freud and the Marquis de Sade in his erotic art and writings. This master of publicity and

propaganda has made sexual perversities the subject of much of his art. According to Dali, art is "a spontaneous method of irrational knowledge based upon the interpretive-critical association of delirious phenomena." [2] His surrealist images were allegedly induced by the "paranoic-critical method" [3] – a delirious interpretation of the world and of the ego, which assumes exaggerated importance. His images of obsession with castration, putrefaction, voyeurism, onanism, and impotence are painted with meticulous realism. Although Dali's technique is precise in terms of modeling and perspective, he converts details, colors, and forms of the material world into images of the obsessions of a madman. His paintings are bizarre combinations and transformations of optical reality.

Many of Dali's paintings deal with autoeroticism and deep sexual anxiety. His art and life read like a textbook of Freudian sexual deviations. Born at Figueras, near Barcelona, Dali claims he has been obsessed since early childhood with masturbation, death, and decay. The young Dali was fascinated with Freud, who recognized the literalness with which Dali used Freudian symbols. Dali, who was inspired toward an art of free fantasy by reading Freud's Interpretation of Dreams, first met Freud while a student in Madrid. Later, in 1938, he was reintroduced to Freud in London. The psychiatrist acknowledged Dali's obsession with the unconscious but wondered where the rational world existed in Dali's domain. He told Dali, "It is not the unconscious I seek in your pictures, but the conscious." [4]

Breton welcomed Dali, and his outrageous behavior and shocking symbolism, when Dali first joined the surrealist movement in 1929. During the next five

or six years he remained in Paris, Dali managed to intimidate his colleagues, who eventually repudiated him. However, Dali continued to practice Surrealism, and made the movement live in his art, for the next fifty years. Dream images were essential to Dali, who claims that his painted images were waking dreams that arrived already formed and had to be translated on the canvas.

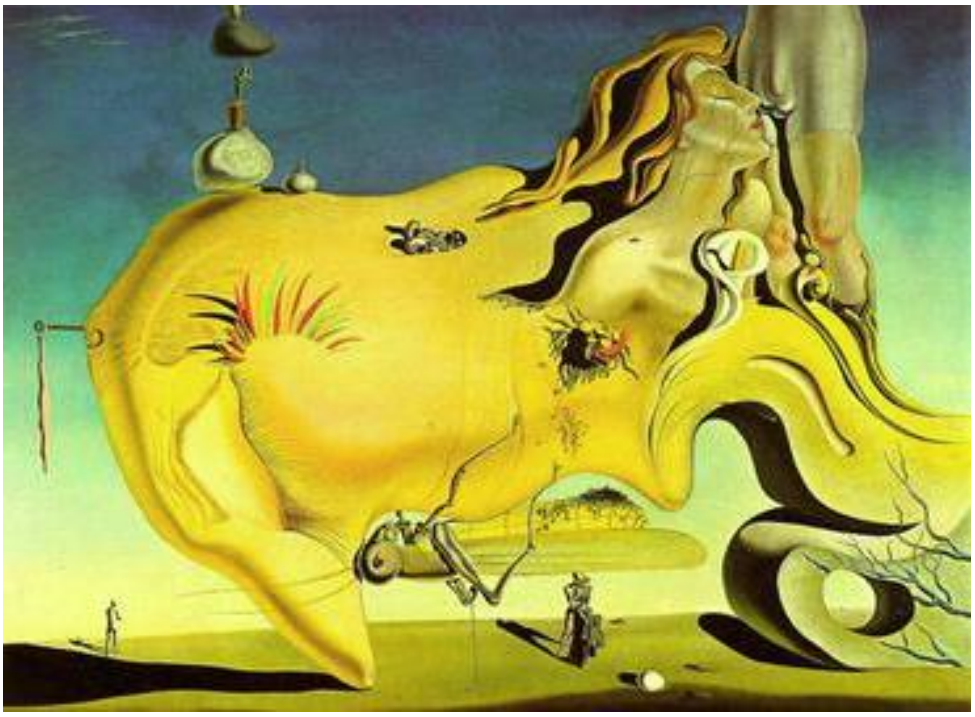


Fig. 2: Salvador Dali, The Great Masturbator

His most prevalent dreams were masturbatory in nature. Dali created The Great Masturbator in 1929-the year he stole Gala Eluard from her husband, Paul-to release what he called his "heterosexual anxiety"s over his passion for Gala. The Great Masturbator is dominated by the profile of a distorted, fleshy head in a desert landscape. The head is Dali's, and a couple embrace in a sexual pose below the head. A female figure grows from the nape of Dali's

profile; her eyes closed, she reaches with her nose and lips for the genitals of an adolescent boy. A key to understanding the artist's intent is the praying mantis that serves as Dali's mouth: The female praying mantis devours the male immediately after the sexual act. When asked about the theme of The Great Masturbator, Dali stated, "The fantasy of being devoured in the sexual act leads to the solipsistic safety of onanism." [6] Dali's fear of women complemented his fascination with autoeroticism and sadism.

The Marquis de Sade coupled sexual love, not with tenderness, but with cruelty; sexual pleasure resulted from humiliation and the infliction of fear and pain. Dali composed one of literature's most sadistic texts, "Reverie," which was by far the most complex and detailed of the essays to appear in the December 1931 issue of Le Surréalisme ASDLR, in a section entitled "Mediatrons." "Reverie" begins with a description of Dali's state of mind and behavior one October afternoon in his house in Spain as he was wavering between intellectual work and masturbatory practices.[7] Dali's obsession with sodomy, masturbation, and excrement are evident in this long text, as the following excerpts illustrate:

> … lying amid the excrement and rotting straw of a very dark cow shed, and greatly excited by the stink of the place, I sodomized the woman I love....
>
> I sit on the wet stone bench with my two hands I raise my penis with all my might, then I go to the cow shed were Dulita and the two women

are lying naked among excrement and rotting straw… and Dulita is changed into the woman I love." [8]

Dali's daydreams construct a sequence of disturbingly sadistic events that lead Dulita, an eleven-year-old girl, into his cow shed fantasy. The power of the overly graphic essay lies in the reader's confusion over which images are meant to be real and which are fantastic.

Young Virgin Auto-Sodomized by Her Own Chastity (1954) recalls Dali's "Reverie" in oil. The figure of a nude female wearing high-heels dominates the painting. She is shown from the rear, looking out a window onto the Mediterranean. Her buttocks spread and metamorphoses into two phalluses. Below her buttocks is what appears to be a third phallus, ready to sodomize the "young virgin." Two additional, missile-like phalluses shoot above the virgin's head. [9]

Unlike Magritte's, Dali's erotica is frightening rather than comic; and Dali's works are a visual diary of his perverse fantasies. His titles are meant to relate to the images. What is so powerful about Dali's work is the quality of his technique and the freedom' of his imagination. Dali is a master of metamorphosis who has made a career of painting images of fear and paranoia. "The only difference between me and a madman," Dali once stated, "is that I am not mad." [10]

Paul Delvaux creates dreamlike erotic fantasies that are more charming than disconcerting. Delvaux categorically refuses to acknowledge Freud and

recognizes only memory and imagination as specific sources for the formation of his images. The transposition and exposition of the female nude have been fundamental elements of Delvaux's painting since 1934, but there is no evil lurking in these poetic images of nude women. Delvaux completed Pygmalion, one of his most important paintings, in 1939. Here Delvaux reverses the well-known theme by exchanging the masculine and the feminine roles: A nude sculptress embraces a male sculpture. The male is a partial figure, truncated at the thighs and upper arms; however, he appears to be metamorphosizing in his abdominal and genital area into living flesh at the sculptress's touch. She gazes at her creation with obvious desire, anxious to place her belly next to his. The feminization of the Pygmalion myth, which ended in Galatea's liberation from stone, has turned the female figure into the creator.

The man is the ideal figure projected by the woman: He has no arms or legs, but is equipped with a beautiful face and a substantial phallus. Juxtaposing eroticism with poetic and highly romantic dream imagery, Delvaux's Pygmalion exists in a surreal space outside the sculptress's studio. A nude female who is becoming a tree, or a vine in the process of becoming a human, appears in the right side of the composition. A gentleman with derby and cane walks past a two-story building toward dunes.

Sex in surrealist art, as these examples illustrate, is linked with daydreams, dreams, and nightmares. Surrealism's power lies in the strangeness of its encounters, and the surrealists' erotic art emphasizes the chance encounter. Surrealism's genesis entailed a powerful exploration of the unconscious

through the negation of as many as possible of the psychological defenses of control, suppression, and active intervention. The preoccupation with sexual imagery in much surrealist art is an affirmation of this elevation of the poetic imagination. Imagination, memory, and obsession prevail over current, mundane preoccupations in the surrealist realm.



Fig. 3: Paul Delvaux, Pygmalion

NOTES

1. André Breton, "Manifesto of Surrealism" (1924), in Manifestoes of Surrealism, eds. Richard Seaver and Helen R. Lane (Ann Arbor: University of Michigan Press, 1927), p. 26.
2. Maurice Nadeau, The History of Surrealism, trans. Richard Howard (New York: Macmillan, 1965), p.67.

3. Paul H. Walton, Dali & Miro (New York: Tudor Publishing Company, 1967), p.8.
4. Dawn Ades, Dali and Surrealism (New York: Harper and Row, 1982), p. 74.
5. Ibid., p. 59.
6. Gert Schiff, Images of Horror and Fantasy (New York: Abrams, 1978), p. e0.
7. Marcel Jean, The Autobiography of Surrealism (New York: Viking Press, 1980), p.272.
8. Ibid., pp. 272 and 275, citing Dali's "Reverie."
9. Dali expert Paul Walton identifies the phallic projectiles as rhinoceros' horns. He writes, "Dali maintains that this combination of a female nude with rhinoceros horns creates an image of innocence, because he associates the rhinoceros horn with the horn of the unicorn, a medieval symbol of chastity." Dali & Miro, p. 28.
10. Sarane Alexandrian, "Introduction," Dali Paintings (New York: Tudor Publishing, 1969).

{From: *Eros in the Mind's Eye*, 1986}

La Femme Fatale Mata Hari en couleur

Over the course of the past century it has become evident that women … *Les Femmes Fatales* …tend to be the best agents for human intelligence gathering, playing on their charms in a measured and calculated fashion.



One of the great *Femme Fatale* of 20th century espionage is Mata Hari, née Margareta Gertruda Zelle (1876-1917).

There have been many books written about her and a few films produced, included a classic starring Marlene Dietrich and another in the 1980's that was somewhat erotic …

Even today, a century after her execution in 1917, historians differ as to her guilt or innocence. My study of her case, tells me that she was guilty as charged, but that Mata Hari should not have perhaps been executed for her espionage.

La Femme Fatale Mata Hari en couleur

Au cours du siècle dernier, il est devenu évident que les femmes… Les Femmes Fatales … ont tendance à être les meilleurs agents de collecte d'intelligence humaine, jouant de leurs charmes de manière mesurée et calculée.

L'une des grandes femmes fatales de l'espionnage du XXe siècle est Mata Hari, née Margareta Gertruda Zelle (1876-1917).



Il y a beaucoup de livres écrits sur elle et quelques films produits, dont un classique avec Marlene Dietrich et un autre dans les années 1980 qui était quelque peu érotique…

Encore aujourd'hui, un siècle après son exécution en 1917, les historiens divergent quant à sa culpabilité ou son innocence. Mon étude de son cas, me dit qu'elle était coupable, mais que Mata Hari n'aurait peut-être pas dû être exécutée pour son espionnage.



























L'espionne Mata-Hari a été fusillée hier matin à Vincennes

C'est hier matin qu'a été passée par les armes la danseuse Mata-Hari — ou plutôt l'espionne Marguerite-Gertrude Zelle, qui avait profité de l'accueil qu'on lui faisait dans notre pays pour le trahir pendant plusieurs années. Elle avait été condamnée à mort le 24 juillet dernier par le 3e conseil de guerre de Paris, pour espionnage et intelligences avec l'ennemi.

Avant la guerre, elle était déjà à la solde de l'Allemagne. Fréquentant, à Berlin, les

Mata-Hari Cl. Talbot.

milieux politiques, militaires et policiers, elle était immatriculée sus les registres de

French Newspaper article, October 16, 1917

The Legendary Mata Hari by Winfried Ludecke

[Excerpt from: *Behind the Scenes of Espionage*, Winfried Ludecke, 1929]

Mata Hari, "*the Eye of the Morning*," was the poetic Javanese pseudonym adopted by a famous variety artist, who, according to her papers, was a divorced woman named MacLeod née Margareta Gertruda Zelle. She was born in 1876 in Leeuwarden, in Holland, and became one of the subtlest and cleverest secret agents thrown up by the First World War. This international Courtesan, the mistress of Ministers, officers and artists of all nations; this woman, whose insatiable thirst for luxury and money brought many a man to beggary, was at the same time a dancer, who, with the play of her supple naked body in Indian temple dances, roused to thunderous applause the music-hall public in London, Paris, Berlin and Rome.

This adventuress, who was as much at home in Sydney, New York and Cairo as in her elegant mansion, No. 11 rue Windsor, Neuilly, Paris, paid for by a millionaire marquis; this *demi-mondaine* with the airs of a great lady, who, in Germany, raved over her disappointed love for the Crown Prince, and in France, indicated the Russian Captain Marov as the one man whom, in all her life, she had truly loved; this bewitching sorceress of love and art also entered the dangerous province of espionage, for which, by her beauty, her great intellectual gifts and her daring, she certainly seemed remarkably well qualified. Was it the titillating stimulus of danger she sought, or was it the lust of gold that this career promised so quickly to satisfy, that made her enter upon the path that led to her end to Vincennes?

In the trial that took place in the year 1917 behind closed doors in Paris the story of her life that was unfolded was like some sensational film drama. Some interesting details have been made public by Major Count Massard.

On the day of the declaration of war Mata Hari was in Berlin, where she was appearing in the Wintergarten as an Indian dancing girl. By the German Secret Service, who registered as H.21, she was commissioned to go to Paris, which did not entail any great difficulty for her, seeing that she was a Dutch subject and therefore neutral. She received the handsome sum of thirty thousand marks, and went via Belgium, Holland and England to Paris, on the pretext that she was going to break up her house in Neuilly. From Paris she went, after a time, to the French Front, staying at Vittel for many months disguised as a nurse. It was here that she devoted herself to the severely wounded and blind Russian officer Marov, which she appears to have tended with really touching care, asserting that she loved him passionately. All through this period she was in uninterrupted correspondence with the chief of the German intelligence service in Amsterdam. Her letters were forwarded by the Dutch Embassy in Paris, who were under the delusion that she was corresponding with her daughter in Holland. It was a simple matter for the beautiful hospital nurse to gain the confidence of the French officers, and especially the flying-officers, from whom, in moments of amorous delight, she obtained valuable military information. She was able to give the German Army command most useful details as to the disposition of French spies on the German front, and betrayed the preparations that were being made for a French counter-offensive in 1916.

The British Secret Service was the first to warn the French authorities against her, and at last they too had their suspicions aroused. When she became aware that she was being observed she quitted the front and returned to Paris. But even here she did not feel safe. What was she to do? She did what most spies are wont to do in such circumstances: she offered her services to the other side. She went to the Second Bureau of the French General Staff and made a statement purporting to give the points on the Moroccan Coast where German submarines were sheltering: the statement was, of course, an invention. At the same time she proposed that she should be sent to the occupied zone in Belgium, to convey instructions to the French agents posted there. The French Secret Service pretended to accept the offer, and handed her a list of all the names of their people employed at the time in Belgium. But this list was really a trap; for, of the names included in the list, only one was genuine; and this exception was that of an agent who, they had good reason to believe, was a double spy. Three weeks later this man was shot by the Germans in Brussels. Only Mata Hari could have given him away, by communicating the list, somehow or other, to the enemy.

She had not left Paris; but as she belonged to the neutrals and there was absolutely no clear proof that suspicion was well founded, they did not care to proceed at once to arrest her. She was allowed to leave France.

Here the account of her movements is somewhat obscure. It is certain that she managed to find her way to Germany, for a personal friend of the Crown Prince ran across her in the street in Cologne, and had a long talk with her.

She gave him to understand that she intended to go back, sooner or later, to France and would not be dissuaded, alleging she had a professional engagement to keep. On leaving him she used these curious and telltale words: "Remember me as a woman who has done and suffered much for Germany."

It is also certain that the British authorities were aware of her movements. They managed to secure her person, probably arresting her on board ship, and conveyed her to London, where she was subjected to a very thorough cross-examination by Sir Basil Thomson, the Chief of Scotland Yard. With consummate skill she strove to avoid all the traps that were laid for her, and the interview ended most unexpectedly on her admission that she was indeed a spy, but for France, not for Germany. She was sent off to Spain; with what commission is not stated.

Her arrival there was, of course, known to both sides, and from the moment she set foot on shore in the port of Gijon, a French Secret Service agent attached himself to her, following her wherever she went and taking care never to let her out of his sight. He was, from the start, so successful in his job that, on the very day of her landing, he had a photograph taken and sent to his employers, which showed himself and the all-unsuspecting dancer on the one plate. In Madrid she took up her abode in a well-appointed suite of rooms in a fashionable hotel, and was soon on very intimate terms with a particularly fascinating German attaché there. Her relations with him developed quickly into a regular liaison. There was no opportunity of bringing her charms to bear directly upon the King, who would certainly have known much of what

mattered most at that moment concerning Entente policy, so they endeavoured to bring an association between her and the French Military attaché, who lived in the same hotel. But of him she could make nothing. Having been warned beforehand, he successfully repelled all the advances she made to him, on every conceivable pretext.

The German attaché gave the lady one or two dainty trinkets, but Mata Hari needed money, always money. So, as they could make no further use of her as an agent in Spain, it was decided to send her back to Paris, where in any case, as she had told her friend in Cologne, she wished to go. And it was then that the thing was done that sealed her fate.

The attaché sent an urgent wireless message to the chief of the intelligence service in Amsterdam requesting to have fifteen thousand pesetas paid to H.21, by intermediary of the Dutch Embassy, on her return to Paris. That wireless message was intercepted by the Eiffel Tower; and as the French were by this time informed of Mata Hari's letter and number, it was resolved to arrest her. She was allowed to return to Paris, in order to receive payment due at the Dutch Embassy, and almost immediately after she paid this call the police conveyed her to St. Lazare prison.

The proceedings before the court martial were not without dramatic episodes. Mata Hari made ingenious efforts to defend herself. She admitted quite frankly the various remittances from Amsterdam and her correspondence with the chief spy in Holland, whose mistress she said she was. But, she protested, it was not a question of spying at all, but simply a love affair. She had

certainly been a courtesan, but never a spy. Her advocate, an old gentleman of seventy-five, who appeared to be in love with her, and chivalrously lavished her with flowers and sweetmeats upon her, cited as a witness for the defence a French diplomatist who occupied an exalted post in the Foreign Office. He had been her first lover after her divorce, and with him she had spent three evenings on her return from Madrid. He testified that the subject of their conversation had been about Indian art. A very intimate document from a French Minister of War was read aloud and provoked in the court a significant smile. Apparently Mata Hari had used these connections to give herself the necessary importance in the eyes of her employers.

She was unanimously condemned to death, and heard the sentence with a convulsive sort of a smile and a shrug of her shoulders. On the day before her execution she was dancing in her cell and took a bath. She had asked to be allowed to bathe in milk, but had to be satisfied with water. The execution took place at six o'clock on the morning of October 15th, 1917.

The Dutch Government had vainly tried to intervene at the last moment; and, as vainly, her counsel had tried to obtain a reprieve by appealing to a certain article of the criminal code, affirming that she was pregnant by his agency. Mata Hari would not have anything to do with this line of strategy, and refused to undergo the medical examination.

She wrote a few letters of farewell, and then entered the motor-car that conveyed her, accompanied by a military escort, to Vincennes. As proud as a princess she walked past the file of soldiers, who were standing at the present.

She bade farewell to her advocate, who embraced her, and to the Sister of Mercy who had watched over her and tended her in her cell, and then received the last words of consolation from the priest.

A gendarme led her to the stake to pinion her, but she objected. She likewise refused to be blindfolded. The officer in charge of the firing party raised his sword. The drums rolled. The clergyman stepped aside. Mata Hari smiled and threw a kiss to the lawyer and the priest.

Then, short and sharp, came the order "Fire!". A sergeant-major gave her the coup de grace by firing his revolver into her ear. The doctor certified her death. The body of the beautiful dancer and spy, once so ardently loved and admired, was thrown into a plain whitewood coffin.

Finita la commedia!

Mathematics

Light Deflection in Newton's and Einstein's Elevator

by Patrick Bruskiewich
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Abstract

In this paper a comparison is made between the deflection of light in a Newtonian Elevator compared to a post-Newtonian Elevator. The first Newtonian estimates of the deflection of light were made in 1804 by Sodner with a published estimate of 0.84" of arc. In the Newtonian Elevator time is considered absolute, while in a post-Newtonian elevator space-time is relative. The light deflection in a post-Newtonian Elevator is on the order of twice as great as that of a Newtonian Elevator. Estimates of light deflection in a post-Newtonian Elevator will be made first using the Classical Doppler Shift and also Planck's equation. These estimates are post-Newtonian and pre-Einsteinian results, and precede Einstein's 1916 Theory of General Relativity. In turn, the estimates of the deflection of light based on Special Relativity and on General Relativity will be outlined. The estimate based on General Relativity will be deemed that for the Einstein Elevator. Taking measurements of light deflection of stars near the sun during a solar eclipse is notoriously difficult. Only a few dozen such measurements have been made over the past century beginning with the famous 1919 Eddington expedition. Results from measurements made 1919 to 1952 will be outlined. It is a tribute to Eddington that his 1919 light deflection measurements of (1.98 ± 0.16)" so closely correlates with the modern day measurements.

The 1804 Sodner's Estimation of the Deflection of Light

The deflection of light near a stellar body was first predicted when Johann Georg von Sodner did the first estimate of this deflection in 1804. Sodner was a German astronomer at the Potsdam Observation near Berlin. Sonder's estimate is based on Newtonian physics and absolute time. The idea began to be discussed in the latter half of the 18th century among European astronomers and mathematicians that Sodner's theory could be tested empirically. Sodner predicts a Newtonian deflection on the order of [1]

$$\theta_{Sodner} = 0.84\ "$$

When you calculate the Newtonian value, using modern values for the radius and mass of the Sun and the speed of light for a trajectory that glazes the surface of the Sun you estimate a deflection on the order of

$$\theta_{Newtonian} = \left(\frac{2\,GM}{c^2\,R}\right) = (0.875\ \pm 0.018)"$$

Over a century after Sodner published his estimate, Albert Einstein, who was at the Kaiser Wilhelm Institute in Berlin at the time may have either read the Sodner paper or discussed the matter with astronomers from Potsdam and decided to revisit the matter of light deflection in a series of papers from 1911 to 1913 and later in an expanded 1916 paper in which he outlines his Theory of General Relativity. In the earlier papers Einstein produced estimates

comparable to those of Sodner. In his 1916 paper Einstein provides a more complete estimate that the deflection would be 1.75" or twice as great as the Newtonian prediction).

Some historians of science claim that Einstein was unaware of the Sodner results. However it is hard to believe this given the close association of the Potsdam Observatory and the Kaiser Wilhelm Institute. Historians of science will confirm that Einstein was himself often loath to mention the work of predecessors in many of his papers, such as his reading of the 1903 translation of the Hull-Nichols paper about light, a paper from which you can draw the conclusion $E = mc^2$.

In 1919 the British Astronomer Eddington undertook his famous solar eclipse expedition to Sobral to measure the deflection of starlight by the sun, announcing that the measured deflection value of [2]

$$\theta_{Eddington} = (1.98 \pm 0.16)\ "$$

was closer to that predicted by Einstein (1.75 " or twice as great as the Newtonian prediction).

It is worth noting that during the latter part of the 19th century several unsuccessful attempts were made to measure the deflection of light near the limb of the Sun during a solar eclipse. The first successful attempt was Eddington 1919 expedition, 115 years after Sodner's paper was published.

Light Deflection in Newton's Elevator

This is a *Gedankenexperiment* (aThought Experiment) about an elevator governed by Newtonian Physics.

Imagine you are in a square elevator of dimension L x L meters, in deep space far away from any gravitating mass, accelerating upwards with value g. If you want to be dramatic imagine there is an *Elevator Gremlin* that is tugging on the cable accelerating your elevator in linear direction through space.[3]

Imagine you shoot a particle on a trajectory perpendicular to the left wall towards the right wall of the elevator. If there is a perpendicular line drawn from the particles starting point to the opposite wall you will notice the particle will hit the right wall a distance d below this perpendicular line given by

$$d = \frac{1}{2}\, g\, t^2$$

where t is the time it takes the particle to cross the elevator, namely

$$t = \frac{L}{v}$$

where v is the speed of the particle. Therefore

$$d = \frac{1}{2}\, g\, \left(\frac{L}{v}\right)^2$$

If the particle is travelling at the speed of light c, and if we assume absolute time, then this defines the Newtonian light deflection distance

$$d_{Newtonian} = \frac{1}{2}\, g\, \left(\frac{L}{c}\right)^2$$

Using Newton's Elevator to Recover the Sodner Result.

Using this *Gedankenexperiment*, we can recover the Sodner result.

Imagine now that your elevator is as big as the diameter of the Earth, so that L = 2R, and that the force of gravity does not vary appreciable over that distance, then

$$d_{Newtonian} \sim \frac{1}{2}\, \frac{GM}{R^2}\, \left(\frac{2R}{c}\right)^2 = 2\, \frac{GM}{R^2}\, \left(\frac{R}{c}\right)^2$$

Estimate the deflection angle as the ratio of the Newtonian distance d divided by R so that at small angles

$$\tan\theta \sim \theta = \frac{d_{Newtonian}}{R} \sim 2\, \frac{GM}{R\, c^2}$$

which recovers the Sodner result from 1804.

A post-Newtonian Estimate based on the Classical Doppler Shift

Let us now explore how the Classical Doppler shift provides a post-Newtonian result. In this *Gedankenexperiment* we are sending light signals up from the floor.

Consider the Classical Doppler shift as applied to a clock at rest with natural period T_0. In a frame of reference that is traveling at speed v upwards the measured elapsed time for a second clock is T', namely

$$T' = \left(1 + \frac{v}{c}\right) T_0$$

Let the moving clock start from rest and travel some distance h at an acceleration g, then

$$T' = \left(1 + \frac{gt}{c}\right) T_0$$

You will note that the velocity is not constant in this derivation. Assume we use light to measure time then the light will have travelled a distance L in time t, namely

$$t = \frac{L}{c}$$

So then, to first approximation,

$$T' = \left(1 + \frac{gL}{c^2}\right) T_0$$

We see that

$$\frac{T' - T_0}{T_0} = \frac{gL}{c^2} = \frac{\Delta T}{T_0}$$

This means then that

$$c\,\Delta T = \frac{gL}{c}\, T_0$$

Let T_0 be the time it took the light to travel from the floor to the ceiling of the elevator when the elevator was at rest (therefore L, the length of the box) and let the left hand side represent the distance of deflection $d_{Doppler}$ of the light beam, then

$$d_{Doppler} = \frac{gL}{c}\left(\frac{L}{c}\right) = g\, t^2$$

By inspection we see immediately the deflection of a light beam in this Elevator is twice that determined for the Newtonian Elevator,

$$d_{Doppler} = g\, t^2 = 2\, d_{Newton}$$

It is interesting to notice that this deflection estimate does not require the use of either Einstein's Special or General Theory of Relativity.

A post-Newtonian Estimate of Light Deflection based on Planck's Equation

Consider Planck's Equations as applied to a light source at rest with frequency f_0,

$$E_0 = h\, f_0$$

A photon is sent upwards from the floor of the elevator, or equivalently against a gravitation field of strength g which is pointed downwards over a distance h.

By inspection

$$E_0 = E_1 + \Delta U = E_1 + m\, \vec{g} * \vec{h}$$

where we recognize that the intrinsic energy of the photon changes, and that both g and h as being vectors, and take the dot product of the two vectors.

Assume now that the photon has an equivalent mass given by

$$m = \frac{E_0}{c^2}$$

so then

$$E_0 = E_1 + \left(\frac{E_0}{c^2}\right) \vec{g} * \vec{h}$$

From whence we find in terms of frequency that

$$f_1 = f_0 \left(1 - \frac{\vec{g} * \vec{h}}{c^2}\right)$$

We see that since gravitation is conservative, we have only to deal with the initial and final states of the photon. Clearly

$$\frac{f_1 - f_0}{f_0} = \frac{\Delta f}{f_0} = -\frac{\vec{g} * \vec{h}}{c^2}$$

Let us now change our frame of reference from frequency f to period T so that

$$\frac{\Delta f}{f_0} = -\frac{\Delta T}{T_0}$$

Which means that

$$\frac{\Delta T}{T_0} = \frac{\left|\vec{g} * \vec{h}\right|}{c^2} = g\frac{h}{c^2}$$

We can reorganize this expression to

$$c\,\Delta\,T = \; g\,\frac{h}{c}\,T_0$$

Assume we use light to measure time then the light will have travelled a distance h in time T_0, namely

$$T_0 = \frac{h}{c}$$

Let T_0 be the time it took the light to travel from the floor to the ceiling of the elevator when the elevator was at rest (therefore h = L, the length of the box) and let the left hand side represent the distance of deflection d_{Planck} of the light beam, then

$$d_{Planck} = \frac{gL}{c}\left(\frac{L}{c}\right) = \; g\,t^2$$

By inspection we see immediately the deflection of a light beam is again twice that determined for the Newtonian Elevator,

$$d_{Planck} = \; g\,t^2 = \; 2\,d_{Newton}$$

An Estimate of Light Deflection based on Special Relativity

Let us transform the expression from the Newtonian Elevator

$$d = \frac{1}{2}\, g\, t^2$$

to that for a moving Einsteinian elevator, keeping the form of the equation, namely

$$d' = \frac{1}{2}\, g'\, t'^2$$

By inspection [4] we see that

$$g' = \gamma^3\, g$$

which makes sense by dimensional analysis, and for the time dilation that

$$t' = \gamma\, t$$

So that

$$d' = \gamma^5\, \frac{1}{2}\, g\, t^2$$

Let us assume the elevator is travelling at a small velocity v, hence

$$\gamma^5 = \frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{\frac{5}{2}}} \sim 1 + \frac{5}{2}\frac{v^2}{c^2}$$

which means then that for the case of Special Relativity

$$d_{Special} = \left(1 + \frac{5}{2}\frac{v^2}{c^2}\right)\frac{1}{2}\, g\, t^2 = \left(1 + \frac{5}{2}\frac{v^2}{c^2}\right) d_{Newtonian}$$

From which we find that

$$\frac{d_{Special} - d_{Newtonian}}{d_{Newtonian}} = \frac{\Delta\, d}{d_{Newtonian}} = \frac{5}{2}\frac{v^2}{c^2}$$

How then may we interpret this? On the right hand side we can estimate the ratio of speeds by using the work-energy theorem, namely

$$\frac{1}{2}\, m\, v^2 = \frac{GMm}{R}$$

which provides for the ratio

$$\frac{v^2}{c^2} = \frac{2GM}{R\, c^2}$$

You may view this as somewhat artificial but it is worth remembering that gravitation is a ‘conservative force’ and so it is the end states and not the path

from the initial to the final state that defines the change. In some sense this would represent a boost from a rest state to a state of relative speed v.

Let us consider the left hand side of the ratio in terms of geometry. By inspection

$$\frac{\Delta\, d}{d_{Newtonian}} = \tan\vartheta$$

We find then that

$$\tan\vartheta \sim \theta = \frac{5}{2}\left(\frac{2GM}{R\, c^2}\right) = \frac{5}{2}\,\theta_{Newtonian}$$

Using Special Relativity you arrive at a light deflection that is on the order of 2.5 times that of the Newtonian deflection. Let us use a Newtonian angular deflection estimate of

$$\theta_{Newtonian} \sim 0.875"$$

From whence we arrive at an estimate for light deflection of

$$\theta_{Special} = \frac{5}{2}\,\theta_{Newtonian} = 2.19\,"$$

Which is slightly higher than twice that of the Newtonian deflection.

An Estimate based on General Relativity: Einstein's Elevator

The estimate of light deflection provided by General Relativity is the most widely described Einsteinian prediction and is well presented in numerous books like Tolman's *Relativity, Thermodynamics and Cosmology*. [5]

Without going through a derivation, the angle predicted by Albert Einstein using his 1916 Theory of General Relativity for light deflection is

$$\theta_{General} = 2\,\theta_{Newtonian} = \frac{4GM}{R\,c^2} = 1.75\,''$$

at the rim of the Sun.

One way to approach this prediction is to realize that the *spatial* (radial) and the *temporal* (time) terms in the Schwarzschild metric have quasi-similar metric terms (understanding how space and time dilations are expressed in Special Relativity). If the Newtonian estimate only recognizes a contribution due to spatial effects, the effects due to space-time in General Relativity would therefore be twice that predicted by Newtonian gravity.

In flat space time, expressed in spherical coordinates, the proper length is

$$ds^2_{Flat} = -dr^2 - r^2 d\theta^2 - (r\,\sin\theta)^2\,d\varphi^2 + c^2 dt^2$$

while in the Schwarzschild metric, the proper length is

$$ds^2_{Schwarz} = -\frac{1}{1-\frac{2GM}{Rc^2}}\, dr^2 - r^2 d\theta^2 - (r\ \sin\theta)^2\, d\varphi^2 + \left(1-\frac{2GM}{Rc^2}\right) c^2 dt^2$$

The difference between the two metric representations of the proper length is

$$(ds^2_{Schwarz} - ds^2_{Flat}) = -\left(\frac{1}{1-\frac{2GM}{Rc^2}} - 1\right) dr^2 + \left[\left(1-\frac{2GM}{Rc^2}\right) - 1\right] c^2 dt^2$$

For weak gravitational fields this can be approximated by

$$(ds^2_{Schwarz} - ds^2_{Flat}) = -\left(\frac{2GM}{Rc^2}\right) dr^2 - \left[\frac{2GM}{Rc^2}\right] c^2 dt^2$$

If we measure distance along the radial direction dr^2 by using a light signal

$$dr^2 = c^2 dt^2$$

then

$$\Delta ds^2 = -2\left(\frac{2GM}{Rc^2}\right) c^2 dt^2$$

The ratio then would be a measure of the deflection from flat space-time, namely

$$\frac{\Delta ds^2}{c^2 dt^2} = \sin\theta \sim\theta = -\frac{4\,GM}{Rc^2}$$

(the negative sign is of little consequence) which means that

$$\theta_{General} = 2\,\theta_{Newtonian} = \frac{4GM}{R\,c^2} = 1.75\,"$$

which is evidently twice that of the Newtonian Deflection. There are a half dozen more rigorous ways in which to arrive at this result.

The Measured Deflection of Light 1919 to 1952

A review of past light deflection measurements from 1919 to 1952 from solar eclipse[6], provides for a mean deflection near the rim of the Sun of

$$\theta_{Empirical} = (1.95 \pm 0.34)\,"$$

which is about 2.2 times that of the Newtonian deflection, and is comparable to the estimate provided by Special Relativity. A careful read of the von Klüber paper shows the variety of interpretation of the data. For instance Danjon cites 1.99” while Mikailov cites 2.01” and uncertainties on the order

of 10%. Measurements from the 1970's onwards using the occultation of Quasars arrived at a deflection closer to 1.88".

It is a tribute to Sir Arthur Eddington that his 1919 light deflection measurements of (1.98 $\pm$ 0.16)" closely correlates with the modern day measurements.

Conclusion

It is evident that the deflection of light in a Post-Newtonian Elevator is twice that of Newtonian Elevator. This is problematic when claims are made that such measurements serve to validate Einstein's Theory of General Relativity. What this in fact validates is that there is no absolute time in the post-Newtonian world. Perhaps this is telling us that it is the properties of light which is at the heart of this effect, and not that of space-time *propre*. You may want to try your hand at estimating the deflection using the Relativistic Doppler Shift.

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Year	**Deflection in "**	**± Error**
1919	1.98	0.16
1919	1.6	0.4
1922	1.77	0.4
1922	1.75	
1922	1.72	0.15
1922	1.82	0.2
1929	2.24	0.1
1936	2.73	0.31
1936	2.13	1.15
1947	2.01	0.27
1952	1.7	0.1
Average:	1.95	0.324

Einstein's Elevator Gremlin and the Ferris Wheel Question

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Abstract

Einstein introduced the Equivalence Principle in Modern Physics a century ago. The Equivalence Principle is a *Gedanexperiment* that introduces an Elevator Gremlin. If you are in an elevator in free space being accelerated upwards at rate g, there is no way of knowing you are not in the Earth's gravitational field. You can apply the *Elevator Gremlin* to provide rigor and clarity to the Ferris wheel question, a question which tends to confuse new students to physics and perhaps even their instructors.

The Ferris wheel Question

The Ferris wheel question relates to the forces experienced by a person riding a Ferris wheel. Many authors have tried to explain what the net acceleration are at the top and at the bottom riding a Ferris wheel. Almost all of these presentations lack either rigor or clarity. In some cases they appear erroneous.

As a physics undergrad some four decades ago I had the pleasure to be mentored by the remarkable physicist George Volkoff, who was a graduate student of J. Robert Oppenheimer, and also a friend and colleague of Albert Einstein.

George and I once talked about the Ferris wheel question and he presented to me an explanation that was told to him by Albert Einstein. There is only one approach that sorts out the question of the net acceleration experienced by a person riding a Ferris wheel in a clear and consistent fashion: use the Equivalence Principle and, for a matter of amusement and education, Einstein's Elevator Gremlin.

The Equivalence Principle and the Elevator Gremlin

A good definition of the Equivalence Principle can be found in Richard Tolman's book *Relativity, Thermodynamics and Cosmology*. [1] I have a 1950 printing of this book given to me as a personal gift by George Volkoff. Richard Tolman was a colleague and friend of Albert Einstein. On page 174 of Tolman's book we find:

> "To obtain a precise expression of the principle … consider the hypothetical limiting case of a non-accelerating observer in a perfectly uniform gravitational field, as contrasted with a uniformly accelerated observer in a region of free space where the gravitational field can be neglected. In this case the *Principle of Equivalence* makes the definite assertion that the result obtained by the two observers in performing any physical experiment will be precisely identical …"

For a matter of amusement and education, imagine you are in free space in an elevator and Einstein's Elevator Gremlin is tugging on a rope attached to the

top of your elevator, accelerating you upwards with acceleration g. You could very well equally imagine you are in a stationary elevator in a gravity field, with g pointing towards the floor. Without looking out of the elevator, there is no way of knowing whether Einstein's Elevator Gremlin is having fun at your expense, or whether you are at rest on the surface of the Earth.

The Ferris wheel Question

Now imagine you are on a Ferris wheel of radius R rotating at speed v. Let us forget that the Ferris wheel is in the gravity field of the Earth and imagine instead it is inside a giant elevator being accelerated upwards at rate g by Einstein's Elevator Gremlin. On a Ferris wheel the centripetal acceleration a_c is always directed towards the center of the wheel … *centri* center *petal* push.

Let me ask you what the net acceleration you feel on the top of the Ferris wheel that is being accelerated upwards at rate g by Einstein's Elevator Gremlin. By inspection:

$$a_{net} = g - a_c$$

By this measure you will feel lighter at the top of the Ferris wheel because the two accelerations are in opposite directions. Einstein himself tested this to be correct.

Let me ask you what the net acceleration you feel on the bottom of the Ferris wheel that is being accelerated upwards at rate g by Einstein's Elevator Gremlin:

$$a_{net} = g + a_c$$

By this measure you will feel heavier at the bottom of the Ferris wheel because the two accelerations are in the same direction. Here too, Einstein himself tested this to be correct.

You may have to dispense with the free body diagram when taking a ride on Einstein's Elevator. Einstein's Elevator Gremlin is the clearest and most direct way of explaining the net acceleration at the top and bottom of a rotating Ferris wheel. I wish to acknowledge and thank both Albert Einstein and George Volkoff for this simple explanation. George tells me Einstein enjoyed his visits to Coney Island …

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